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The Journal of Thoracic Surgery

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The Journal of Thoracic Surgery

VOL. III | OCTOBER, 1933 | No. 1

Original Communications

EXPERIENCES WITH OLEOTHORAX*

J. N. HAYES, M.D., AND LAWRASON BROWN, M.D.
SARANAC LAKE, N. Y.

WE USED oleothorax in treatment for the first time in January, 1926. Since then we have given it to 29 patients. Three of these patients were not receiving artificial pneumothorax at this time nor did they later. From February, 1926, to April, 1933, we have administered artificial pneumothorax to 343 patients and to 26 (7.5 per cent) of these we have given also oleothorax. In 10 of these 26 patients bronchopleural fistula was present and in 7 of them oleothorax was used in an attempt to close the fistula. As this indication is rarely of value, we may exclude it and say that in only 5.5 per cent of our patients with artificial pneumothorax was oleothorax indicated. With wider experience with the treatment we would probably put the figure lower than 5 per cent.

OLEOTHORAX NOT ASSOCIATED WITH ARTIFICIAL PNEUMOTHORAX

The first patient to whom we gave oleothorax, in January, 1926, had sustained a pneumothorax from a permanent bronchopleural fistula with consequent formation of pus. As is usual when this complication occurs with therapeutic pneumothorax, the treatment was unsuccessful. The patient soon died of her infection. Another patient, in the same year, returned to Saranac Lake after a visit to her home. One month previously, while carrying a heavy load of wood, she had pain in the chest and increased cough and expectoration. She probably then developed a bronchopleural fistula. On her return she had indefinite roentgenographic evidence of pneumothorax and effusion into a small pocket. Five months later she suddenly developed a subcutaneous abscess in the left anterior chest wall. The pus in the abscess and in the pleural cavity contained a streptococcus but tubercle bacilli were not seen on smears. The abscess connected with the pleural cavity. As-

*Read at the Sixteenth Annual Meeting of the American Association for Thoracic Surgery, at Washington, D. C., May 9, 10, 11, 1933.

pirations of pus and injections of 10 per cent gomenol in olive oil were made into both. The pleural pocket was small, 600 c.c. of pus being the maximum amount withdrawn. During three months 2775 c.c. of pus were aspirated from the pleural cavity and 1000 c.c. of oil injected into it. Toward the end she evacuated oil and pus through the trachea and died four months after beginning the treatment, which had no effect.

The third patient had had pulmonary tuberculosis since 1917 and had been under treatment since 1923 in Saranac Lake. He had advanced fibrocavernous disease which was not very active. In late May, 1927, he developed symptoms which were difficult to interpret, but later he became very short of breath, had high fever, and fluid was diagnosed in the right pleural cavity. On July 14, 1927, 500 c.c. of pus were aspirated and 100 c.c. of 20 per cent gomenol in olive oil were injected. On July 18, 200 c.c. of pus were found and 200 c.c. of 5 per cent gomenol in oil were injected; on the twenty-fifth, 200 c.c. of the same oil were injected. Although bronchopleural fistula had not been suspected, he said that he tasted oil after the second injection but no oil was seen until August 3 when a few drops appeared. The oil was immediately aspirated from the pleural space. The patient soon felt better, but in December he again had soreness in the right chest, 100° temperature and slight shortness of breath. We aspirated 300 c.c. of pus and injected 300 c.c. of air. Since then he has been quite well but has chronic inactive phthisis. The pus has never reaccumulated. It is difficult to say whether the oleothorax helped him.

OLEOTHORAX IN THERAPEUTIC PNEUMOTHORAX CASES

Maintenance Oleothorax.—To maintain the collapse of a lung in which the activity or progression of tuberculosis has been controlled by artificial pneumothorax but in which expansion, which threatens to undo the beneficial result, has begun, is one of the best indications for oleothorax. Of this so-called maintenance oleothorax, we had 7 cases.

In one patient only the cavity-bearing upper portion remained collapsed and this collapse has been maintained for five and one-half years. She is apparently cured and there appears to be no reason why the paraffin oil should be removed.

In one patient whose two cavities had not been completely closed but were greatly reduced in size, and whose opposite lung was partially collapsed with artificial pneumothorax, oil stopped the progressive reexpansion and, in addition, the collapse has been improved and the cavities have become smaller. The pressure of the oil was gradually increased and has been maintained for two years. No refills of paraffin oil were necessary from August, 1931, to April, 1932. Several refills of 5 to 20 c.c. during that summer reduced the recently increased cough and expectoration. At the same time the mediastinal bulge to the oleothorax side has been eliminated and on the opposite side the upper lobe, which

contained a cavity, has been gradually completely collapsed. Stiffening of the mediastinum permitted higher pressures which were effective.

In another patient with very similar bilateral pneumothorax, the oil pressures were increased to plus 9 cm. of oil and after three months of oleothorax a bronchopleural fistula developed recently. This was preceded by slight fever and an hemoptysis. The fistula may have been due to progressive ulceration from within due to activity of the lesion but we put it down as a result of oleothorax. The outlook for this patient is bad.

The value of maintenance of collapse by oil is well shown in a patient whose right lung had been nearly destroyed by tuberculous ulcerations. After the formation of a mild serous effusion, slow expansion began until a cavity reappeared at the base of the lung. An oil filling prevented further expansion during the last year. On February 1, 1933, he was in an auto accident. A hemorrhage occurred in his pleural cavity and the fluid, which had not disappeared, was found to be bloody pus containing tubercle bacilli, Gaffky VII. He has since recovered from a pericardial effusion after one aspiration. After aspirating and irrigating, the pleural cavity was refilled with oil. At the time of this refilling the small amount of fluid was nearly serous. The patient's disease is quiescent.

In another patient whose effective collapse was early threatened by expansion after serous pleurisy, oleothorax has maintained the collapse for one and one-half years without the necessity of refills. Here again the small amount of fluid became purulent, this time in the early stage of the treatment. It has not been aspirated and the patient's disease is arrested.

A patient had effective pneumothorax for two years. Her serous effusion contained large numbers of tubercle bacilli and, although no pus had developed, two slight needle abscesses formed where refills of air had been given. Oleothorax was substituted fifteen months ago. After one year 1500 c.c. of seropus had accumulated beneath the oil and she was in excellent condition. The oil was not removed with the pus but 1200 c.c. of 5 per cent gomenol in paraffin oil were added to that which remained. The patient continues to work as a nurse. The only signs of intrapleural pressure she had were slight shortness of breath on climbing the stairs and a crackling sound in the chest. These symptoms have been relieved.

In the final case of this series the lung collapsed suddenly during the first attempt at pneumothorax. Gas was aspirated during the next four days leaving a negative pressure which had become positive at the next tapping. No fluid formed. The dyspnea was not too severe for comfort but the heart was very rapid, weak and slightly irregular. Although a perforation was probably still present, the indication was for a maintenance oleothorax because this patient would never have permitted refills of air to be continued. On the sixth and seventh days a total

of a liter of 5 per cent gomenol in paraffin oil was given but it did not fill completely the pleural cavity. Gas pressure above the oil remained negative. The fistula was probably closed. She was not dyspneic but cyanosis became progressively greater and the heart more irregular and more rapid. Thinking that the oil was exerting pressure on the embarrassed heart, half of it was removed. The patient died on the following day due, we think, to cardiac weakness associated with the sudden collapse of the lung in an extremely nervous patient.

Disinfection Oleothorax.—We have used oleothorax to combat tuberculous pus in the pleura in ten cases.

A man, twenty-nine years old, sustained a pneumothorax with serous effusion in March, 1925. The perforation closed immediately and the collapse was maintained with refills of air until his going home in November, 1925. There the effusion increased rapidly filling the pleural cavity. His physician did not aspirate it and stopped giving refills. A year later he resumed work. Films made in 1926 and 1928 show that the heart was gradually pushed to the right side. In March, 1929, after a cold, his accelerated pulse became more rapid and slight dyspnea somewhat embarrassing. He visited a doctor who advised immediate thoracotomy. He returned to Saranac Lake in April, 1929, after refusing that advice. Temperature was normal, pulse 100 at rest. The right border of the heart was in the anterior axillary line. The sounds were loud, the pulsation throbbing, and veins were prominent over the anterior thoracic wall. Cough was excessive and explosive but very little watery sputum was raised. He felt quite well and informed us that he was merely consulting us while on his way to Canada on a business trip. The pus was very thick and contained tubercle bacilli, Gaffky II. Dakin's solution was used to make it thinner. In four aspirations 5650 c.c. of pus were removed and 2600 c.c. of 5 per cent gomenol in paraffin oil were instilled during the month that he remained here. The pleural cavity was not filled completely and the heart had receded somewhat to the left. He was quite comfortable in every way. He returned in July with a pulse rate of 60 although the right border of the heart was still at the right nipple line. Cardiac throbbing was less forcible. Fluoroscopically the oil shadow extended from the third to the sixth rib anteriorly with the darker shadow of a small amount of pus below it. The pleural cavity was nearly filled after injecting another liter of oil. We advised him to return but we did not see him until 1931 when he stayed only a few hours and would not permit us to aspirate some of the oil. No shadow of pus could be seen but the heart was still pushed well to the right. He had no symptoms at all and his letters report that he is in good health.

Another patient developed a large purulent effusion without fever and while she was in excellent condition, seven months after beginning artificial pneumothorax. She had had numerous cavities in the lung

and all were compressed although several adhesions were present. In many such cases the lung expands prematurely. The pleural cavity was completely filled with a liter of 5 per cent gomenol in paraffin oil in December, 1929. She performed all of her own housework and had no symptoms. Two and a half years later the pleural cavity was emptied, 800 c.c. of clear, very slightly yellowish oil having an odor of gomenol, being obtained. During this interval, therefore, 200 c.c. of oil had been absorbed. No pus had reformed. The pleural space was filled with air and no refills were given. Pneumothorax was last seen six months later. The lung expanded very little, the mediastinal structures are now drawn well to the right and a minimal amount of fluid developed in the diaphragmatic sulcus. She has no abnormal symptoms; the circulatory apparatus appears normal and she has recently gone home. I am now sorry that I aspirated the oil but I see no reason at present to reconstitute the oleothorax.

Four patients with severe tuberculous empyema were given oil treatment. In one a relapse of the empyema, which began in 1923, was complicated by a hemorrhagic purulent effusion in 1926. Oleothorax was then kept up for three months, the temperature being practically normal after the first month. Olive oil containing 20 to 10 per cent gomenol was used. It is difficult to say whether the oleothorax added anything to the value of the aspirations. The pus continued to reform and the collapse was given up after resuming pneumothorax treatment. He refused thoracoplasty. His disease is usually quiescent and he has worked most of the time but occasionally has an hemoptysis.

Another patient with severe tuberculous empyema probably had a bronchopleural fistula early in the oleothorax treatment but it became more evident four and a half months later when the oil had been removed and staphylococcus was found in the small amount of pus. She then spat up sputum colored with gentian violet which had been introduced into the pleural cavity. During oleothorax, when she lay on the better side the sputum had a taste which could not be identified as oil and no oil was ever seen in the sputum. We think there are cases, however, in which the perforation is minute and oil does not flow through it. In such cases the aromatic gomenol may be tasted or smelled by the patient, yet no oil can be seen in the sputum. Small amounts of oil may stain the sputum container. This stain should be looked for in these cases. This patient had an ineffective collapse and was always in poor condition. The oleothorax did no good except that the pus reformed slowly. She died two months after stopping oleothorax, during all of which time the fistula was large and the empyema was malignant.

Another patient who had tuberculosis complicating an abscess (post-tonsillectomy) of the lung, developed tuberculous empyema in which large amounts of pus formed rapidly. The oleothorax, which was maintained for two months, did not retard the development of pus. In three aspirations 1400 c.c. were withdrawn during two months. She was

better, however, than at any time subsequently and we now think it was a mistake to have given up the treatment. Seventeen months after returning to pneumothorax treatment, she died from a pneumonic extension to the opposite lung.

A careless patient who had had a fairly effective pneumothorax for five and one-half years developed a streptococcal empyema after a swim. After the streptococcus had been controlled with the use of gentian violet-acriflavin, tuberculous pus remained and he was very sick. The pleural cavity was filled with 5 per cent gomenol in paraffin oil. Thin, watery violet fluid (350 c.c.) was aspirated after one month. At the end of two months he coughed up a small amount of oil and after this he occasionally tasted gomenol and it would be detected as a stain on the sputum cup filler. He continued to develop thin pus and the oleothorax was terminated after two and one-half months. Now after three more years he still has a bronchopleural fistula and a few ounces of pus drain from a thoracotomy tube. He has never been in condition for a thoracoplasty.

In two other patients, the empyema had become relatively inactive when the oleothorax was started. In one of them the pus was very thick and aspiration was difficult. After 250 c.c. had been removed and while the end of the needle was still in pus, 250 c.c. of gomenolated paraffin oil were injected. At this point he became unconscious for a few minutes. After this he said that his vision was blurred and he could not move his right arm or right leg. Within five minutes he had fully recovered. Our diagnosis was embolism of a small amount of oil. It was a very foolhardy thing to attempt to inject oil when it was impossible to control the pressure in the air pocket. No further complication occurred, no more aspirations were needed and he died eighteen months later during a severe hemorrhage from the cavity in the opposite lung.

Another patient demonstrates how easily an unsuspected bronchopleural fistula can be made evident by oleothorax. This patient had a streptococcal empyema after thoracoplasty. Six weeks later a speck of dye in the sputum revealed the presence of a minute fistula. During the next two months gentian violet was occasionally seen in very small amounts staining the sputum. During the following seven months frequent aspirations and irrigations did not prevent the thin tuberculous pus from reforming in the small pleural pocket but although various dyes had been used none was ever seen again in the sputum. We decided to try oleothorax and a few days later he tasted gomenol. The oil was immediately evacuated and a Schéde operation performed. He is now recovering from it.

In a patient with cavities on both sides and only a partially effective collapse on the left side, a streptococcal empyema developed. The secondary infection was controlled with gentian violet-acriflavin and six months later the pleural cavity was filled with 5 per cent gomenol in

paraffin oil to control the tuberculous infection. Pus reformed beneath the oil and high pressure was not suspected until a slight swelling of muscle in the posterior thoracic wall was noticed eight months later. A liter of very thick pus, in which tubercle bacilli could not be found on direct smear, was removed. The oil had been reduced from about 800 to 200 c.c. After using 1:2500 metaphen, the small amount of pus which continued to reform became serous. Therapeutic pneumothorax has been continued during the last nine months and the patient is greatly improved but still has chronic bilateral cavernous disease.

We have recently given oleothorax to another patient with tuberculous empyema of low grade activity. In her case we hope to prevent, or at least slow up, the reformation of pus. She has had several peculiar attacks of dyspnea and tachycardia which were very serious. She will be much better off if aspirations and irrigations can be avoided or even postponed to longer intervals.

MAINTENANCE AND DISINFECTION OLEOTHORAX

In one patient, although pus was present in small amount and had not been aspirated nor had refills been given since August, 1928, the indication for oleothorax was principally to maintain the collapse. The patient had been through a severe *Staphylococcus aureus* empyema following an intrapleural lysis of adhesions one year previous. As usual the reforming pus was tuberculous but it became stabilized. A pleuracutaneous fistula which opened occasionally had developed. His condition was very good. The fistula had not been open for some time when we decided to give oleothorax in April, 1929. No aspirations and no refills of air had been made for seven months, but the lung was not reexpanding and the patient complained of a painful pulling sensation in the involved side of the thorax. After 650 c.c. of oil had been injected he coughed and tasted oil but none was expectorated. The oil had been injected by means of a 50 c.c. syringe with one-needle technic. An equal amount of gas was removed after each syringeful of oil had been instilled. As the oil approaches the summit of the pleural cavity it is evident that the trapped supernatant gas may be subjected to too high pressure by this method. In this case withdrawal of some of the oil quickly stopped the spasmodic cough. The oil was left in for five months at which time it was evacuated through the pleuracutaneous fistula. This has now been healed for several years, the lung has expanded very slowly, a small amount of fluid is still present, but the disease is arrested.

COMPRESSIVE OLEOTHORAX

To attempt, by elevating the pressure of the oil, to close a pulmonary cavity is the most dangerous method of using oleothorax. We have already mentioned one patient in whom a bronchopleural fistula developed

and which may have been due to pressure by the incompressible oil. In another patient, whose history has been recorded in detail (J. Thor. Surg. **2**: 24, 1932) the indication from the beginning was to obtain a compressive oleothorax. Artificial pneumothorax was started after serous pleurisy had developed. The lung was expanding quickly despite high air pressures and it seemed desirable, on account of this and an uncollapsed pulmonary cavity, to push the oil pressures quickly. Oleothorax was begun on July 22, 1930, and nearly a liter of gomenol in paraffin oil was introduced in five seances extending to July 31. The pleural cavity was divided by numerous adhesions into a series of intercommunicating pockets. With the last injection the space was filled and the cavity seemed to be collapsed. Pressure readings of the oil were obtained by allowing the oil to flow up a centimeter pipette attached to the needle. After the last injection the oil rose 21 cm. On the following day she became sick and she died two days later as a result of oil embolisms of the lungs, liver, spleen, and kidneys. Petechiae of the skin were seen after the second injection and they were possibly due to minute oil emboli. No oil was ever expectorated. The pleura at autopsy was thinly caseated and a shaggy fibrino-fibrous exudate overlay it. The capillaries of such tissue are thin and it is our belief that oil was forced into them by pressure from the pleural cavity.

BRONCHOPLEURAL FISTULA

This was the indication for oleothorax in seven cases. Such treatment is not useful in overcoming this complication although Bernou aroused enthusiasm for it with an early optimistic report. Secondarily infected pus is nearly always present. Most of our cases were tried in the early years of our experience with oleothorax. Two patients survived the perforation seven and ten months but the others died within one week to one month after this accident. Most of them coughed up oil in moderate amounts but it seemed to do no harm. In two patients who were examined at autopsy no evidence of inflammatory effect of oil on the parenchyma of the lung could be found. Several patients had less cough and less disagreeable expectoration after oleothorax had been instituted. One patient, however, complained that the taste of the gomenolized oil affected his digestion badly.

Technic.—The general technic has been well described by several authors. We have followed French workers in using gomenol in oil, expecting at least some antiseptic action in cases of infected pleurae. If the oil medium first used (e.g., paraffin) has no action on the pleurisy, another (olive, cotton seed oil) should be tried. We prefer plain paraffin oil for maintaining collapse when the pleural cavity is dry and 5 to 10 per cent gomenol in paraffin oil when pus is present. Fluid should be aspirated and preferably the pleural cavity should be irrigated before

introducing oil. In these cases no test doses are necessary and large amounts can be injected at once. We use a 10 c.c. syringe with large finger clasps, a three-way adapter and an 18-gauge needle. A rubber tube extends from the side arm of the adapter to the flask of warmed oil. We frequently use only one needle for the first fillings, alternately aspirating gas and injecting oil. But as one approaches the point of filling the pleural cavity two needles should be introduced, one for oil and one for escape of gas and for registering pressures. They may be placed near each other high in the chest. In severe empyema the possibility of a small and perhaps intermittent bronchopleural fistula should be remembered and two needles are advisable, to be certain that the gas pressure is not elevated.

With the final injection we usually find that the pleural space is not quite filled but the bubble of gas at the apex is soon absorbed. The point of injection is massaged and a binder is put on if the axilla has been the site of injection. We have seen oil escape into the subcutaneous tissue only once and then in small amount and it did no harm.

The patient must be under observation for a reaccumulation of pus beneath the oil. In the x-ray film and usually with the fluoroscope one can see the line of demarcation between the darker shadow of fluid and the lighter shadow of oil. If the oil is not absorbed as the fluid forms, too much pressure may be exerted. One patient had slight shortness of breath and a crackling sound of mucus in the bronchi; another had what we interpreted as edema of the muscles of the posterior thoracic wall as a result of increased pressure. In two patients who had had indefinite evidence of perforation, a permanent bronchopleural fistula occurred and it may have been due to increased pressure from this cause.

In the absence of pus a test dose of 2-5 c.c. of oil without gomenol is injected at the end of an ordinary refill of air. Reactions are more common than when pus is present. It is important to make no further injection until the temperature has fallen to the usual level. Failure to observe this rule in one case led to the development of a severe pleural effusion which quickly became purulent. The pleural cavity should be filled more slowly than when fluid is present. As long as gas is present its pressures should be observed. With the alternating method of aspiration of air and injection of oil, we have found that pressures are changed very little. Connection to the water manometer is very important as the gas pocket becomes smaller. Final pressures must always be read. After the pocket is full of oil if it drops slowly from the open needle the oil pressure is low. If it is sucked in toward the pleura it is naturally under negative pressure. For elevated pressure, we use the one cm. pipette described, allowing five minutes for the oil to reach a level. The readings must always be made with the patient in the same position and the needle always at the same spot. These readings are, of course, only

comparative but they seem to us to be useful. One must remember that with the pleural cavity filled with oil a further small amount will increase the pressure very quickly. One should then take pressure readings after each 5 c.c. of oil has been injected.

DISCUSSION

Of the seven maintenance oleothorax cases, we have maintained for from one to five years a collapse which was about to be lost in five patients. In each case at the time of substituting oleothorax for pneumothorax, the lung, in our judgment, had not been collapsed long enough to ensure healing. Tuberculous pus of a very mild nature formed in three of them but led to no inconveniences. One patient died as a result of cardiac weakness not related to the oleothorax, and one is in poor condition due to an infected pleura following bronchopleural fistula. It may have been due to anemic necrosis of a thin-walled cavity which had been subjected to the pressure of oil.

When pus is present oleothorax is most useful in cold abscess of the pleura. In three of these patients pus did not reform after institution of the treatment. In acute severe tuberculous empyema we prefer aspirations and irrigation, but oleothorax was given to two such patients without benefit. In tuberculous empyema of slight or moderate activity, in which pus keeps on reforming in spite of irrigations, gomenolated oil retarded its formation in two cases. The aromatic quality of gomenol will sometimes reveal an unsuspected minute bronchopleural fistula.

If the clinical evidence points to a very small and intermittent fistula and if thoracoplasty is contraindicated, some would advise oleothorax. After having seen the effect of intratracheal injections of paraffin and vegetable oils upon the lungs of experimental animals and in two women, we prefer not to try it except under unusual conditions.

The factors of the incompressibility of oil and the difficulty of controlling its pressure on the lungs make so-called compressive oleothorax dangerous. Some patients will be benefited by it when it is used cautiously, but when the pulmonary cavity is close to the periphery of the lung, great caution should be exercised if oil is to be introduced under pressure.

In our own cases we have had only one patient in whom a deviated mediastinum has been restored to its normal position, and in her case the indication was to maintain and increase the collapse of the lung. We have had the opportunity through the courtesy of a confrere of seeing another patient in whom a very mobile mediastinum prevented a collapse of the lung. After the institution of oleothorax the compression became effective and the mediastinum was rendered more rigid.

The rapidity of absorption of the oil will vary with the kind of oil used and with certain unknown factors in the patient. The technic of administering oleothorax depends upon the problem at hand, but the

most important thing, after choosing the type of patient to whom it should be given, is to control the supernatant gas pressure while the oil is being administered.

CONCLUSION

Maintenance of collapse of the lung is the best indication for oleothorax and in this group of patients we have had our best results. Relatively inactive tuberculous empyema sometimes responds to this treatment.

DISCUSSION

DR. E. J. O'BRIEN (DETROIT).—I would just like to add a word about the use of massive doses or injections of gomenol. We have had several very tragic accidents in which the oil ruptured through the lung and into the bronchus, with drowning, and we are a little afraid of it. We use it mostly in trying to sterilize tuberculous fluids. It has a field, of course. But those accidents have made us a little fearful of it.

DR. NORMAN BETHUNE (MONTREAL).—I was very much interested in Dr. Hayes' paper on oleothorax treatment. We have been using oleothorax for some time, and it has its use as a disinfectant, I suppose, but there are many objections to it. We use it only as a block against reexpansion and for that purpose we are employing pure, sterile cotton seed oil without antiseptics added. We have used it in ten cases for the blockage only, and we have had no reactions.

The objection to injecting 25 c.c. of any oil in the pleural cavity as a test is the difficulty of recapturing that amount of fluid. It is very much easier to find 200 c.c. than 25 c.c. and so if you want to test your reactability or the irritability of the pleural cavity you won't be any worse off if you put in 200 c.c. than if you put in 25.

If we want disinfection we have employed Hunter's acri-gelatin with success, in three cases. It is miscible with the pus, which of course, the oil is not.

Another thing; it is very comforting to know what the pleura looks like, and we are doing a thoracoscopy first. In that way one can estimate roughly how quickly the pleura will absorb oil, see tubercles on the pleura, etc.

We are now paying blackmail on one case of oleothorax of three years' duration. The complaint is a dragging sensation. It is relieved by 25 c.c. oil every six months. How long we will have to pay that we don't know—probably all her life.

DR. GEORGE HEUER (NEW YORK).—Some years ago it was decided to start a thoracic tumor registry somewhat similar to the bone tumor registry. The idea met with a good deal of enthusiasm at the time and at first we received an encouraging number of case reports.

Of late, however, we have had a great deal of difficulty in maintaining interest in the registry. Up to date we have fairly complete records of 133 cases that have been sent in to us. I shall not read you the details of these cases, but they are on file, and of course, available to any man of this Society who is interested in the study of tumors of the thorax.

The reason I am standing before you is to ask you whether you will not try to get in your records. I suggest as a result of my own experience, that when you have an interesting case of thoracic tumor, you make at once a duplicate of the history, physical examination, and other data and send them on rather than wait until you have several cases to report. I have found, and I am sure many of you have, that as material accumulates it becomes progressively more difficult to assemble it. Next year I hope we shall be able to present an exhibit of the registry.

OLEOTHORAX THERAPY*

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OLEOTHORAX therapy is the use of an oil preparation in the intrapleural space for pulmonary compression or for the disinfection of an empyema cavity. This type of therapy is definitely indicated in certain inevitable complications of artificial pneumothorax. The oil is introduced by thoracentesis, using a large gauge needle and injecting the oil by the syringe method. The character of the oil used depends somewhat upon the indication for oleothorax therapy. It may or may not have antiseptic qualities. If an antiseptic quality is required, the strength of such will vary according to ease requirements.

We first definitely instituted oleothorax therapy at Fitzsimons General Hospital in 1931. We first requested permission to adopt the therapy in 1929, but due to inconclusive reports and differences of opinions expressed in current medical literature, permission for its use was denied. In our first few cases we obtained excellent results and enthusiastically accepted this type of treatment. Shortly after this appeared the excellent and comprehensive article of Matson[1] in which he reported results of 100 cases. Following this report one of us obtained permission to study at the Matson Clinic.§ During this study we not only had an opportunity to learn their technic, but had access to the case records forming the basis of their report. It is largely through their kindness that we have been able to improve our technic, insuring more satisfactory results.

As a working basis we have utilized Matson's classification. Since we have wished to be rather conservative, we have used oleothorax therapy only in the conditions given by Matson as definite indications, which follow:

1. Disinfection oleothorax in pneumopyothorax.
2. Inhibition oleothorax in obliterative pneumothorax.
3. Compression oleothorax in unsatisfactory pneumothorax.

Compression therapy in the form of artificially induced pneumothorax is frequently complicated by various types of pleurisies. The seriousness of this complication depends upon the character of the pleurisy. Pneumohydrothorax, though a frequent complication is usually well

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tolerated; the fluid usually reabsorbs spontaneously or disappears after one or more aspirations. This type of exudation is not an indication for oleothorax therapy. Should the exudation become purulent in character, disinfection oleothorax is indicated. Infrequently the exudation rapidly becomes purulent, which in a majority of instances means that there has been a spontaneous pneumothorax superimposed upon the artificial pneumothorax. The pleuropulmonary fistula, though only of a temporary nature, exists sufficiently long to infect the pleural space with tubercle bacilli.

Since it is our routine to do fluoroscopies before and after pneumothorax refills, the detection of superimposed spontaneous pneumothorax is often made when unsuspected. Prior to refill we find the lung compression in excess of that observed at the last fluoroscopy, and this is soon followed by a pleural exudate. The pleural exudate, if sufficiently infected by tubercle bacilli at the time of the pleural rupture, becomes purulent and there is present a tuberculous pneumopyothorax.

In these cases all exudate is removed by aspiration, the cavity irrigated with normal saline, and the initial test dose of gomenolized oil injected. Repeated graduated doses are given at intervals of a few days, during which interval pneumothorax refills are continued to prevent lung reexpansion. Test doses consist of 1 c.c., 2 c.c., 4 c.c., 8 c.c., 20 c.c., 40 c.c., followed by refills of from 100 c.c. to 500 c.c. Before each refill all purulent exudate is removed, irrigated with saline, if necessary, and earlier in the treatment an air refill given to maintain sufficient space until the case can be converted into a complete oleothorax. Test doses are given with 5 per cent gomenolized oil in tuberculous empyema cases. Refills are continued, using 5 per cent gomenolized oil except in obstinate cases, in which instance 10 per cent oil may be used. In disinfection cases we use gomenolized vegetable oil (Mazola, corn oil).

Thoracentesis is performed with the patient in the pneumothorax refill position. He is then placed in the sitting position and purulent exudate aspirated by the syringe method, later inclining the patient to the affected side. Fig. 1 diagrammatically illustrates the sitting position for aspiration. After the aspiration of all purulent material, the patient is again placed in the pneumothorax refill position for the injection of oil as illustrated in Fig. 2. Air is withdrawn after each 25 c.c. to 50 c.c. of oil to avoid excessive disturbance of the intrathoracic equilibrium. This technic is, in brief, that used by Matson.

Table I shows some of our cases of tuberculous empyema treated by 5 per cent gomenolized vegetable oil. In all instances the empyema was a complication of pneumothorax therapy. In one instance the purulent exudate was a complication of a previously induced inhibition oleothorax instituted because of obliterative pneumothorax.

Table I gives brief information concerning 9 cases of disinfection oleothorax for tuberculous empyema. Of the 9 patients 6 have shown what we think is fair to term "immediate response" to treatment with rather rapid disappearance of the purulent exudation. The other 3 patients continue to have purulent exudation. Two of these cases were of long standing prior to oleothorax therapy. The other patient responded well but again developed an exudate which has persisted, probably because he is not in hospital and does not cooperate in routine rest treatment.

The table contains cases which have been completed or which are still under treatment. Treatment has been instituted on several other patients who left the hospital during treatment or immediately after completion of the oleothorax and their condition is at present unknown.

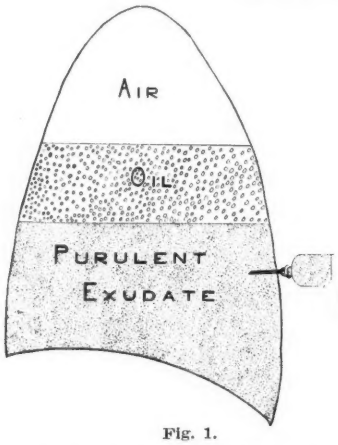

Fig. 1.

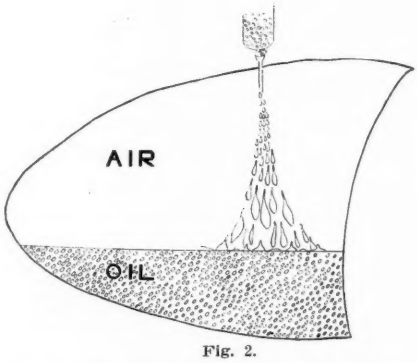

Fig. 2.

Fig. 1.—Showing the aspiration of purulent exudate with the patient in the sitting position. The relation of air pocket, oil, and purulent exudate is diagrammatically shown.

Fig. 2.—Showing the introduction of oil with the patient in the horizontal position. The relation of the air pocket and the oil is diagramatically shown. The exudate was removed while the patient was in the sitting position.

Of the 9 patients with tuberculous empyema only 4 had abnormal temperature at the actual time of purulent exudation. This observation indicates that clinical symptoms cannot be used as a guide to determine whether an effusion is clear or purulent. Longer standing cases of pneumohydrothorax should be observed for the type of exudation by repeated diagnostic aspirations. These 9 cases were infirmary cases under enforced rest care and for this reason the clinical manifestations of pyothorax may have been greatly lessened.

In Table I the record of treatments does not include the test doses but includes only the number of treatments after the dose of 100 c.c. had been reached.

TABLE I

TUBERCULOUS EMPYEMAS—DISINFECTION OLEOTHORAX

NAME	AGE	NO. TREATMENTS	TOTAL AMOUNT EXUDATE REMOVED IN C.C.	TOTAL AMOUNT 5% OIL GIVEN IN C.C.	DURATION OF TREATMENT IN MONTHS	RESULTS
C. W.	38	9	3000	2470	5	No purulent exudate for over 1 yr. Oil has been removed and lung has reexpanded.
W. G.	30	12	1100	1850	7	Purulent exudate no longer present after 7 mo. Patient left hospital 6 mo. later. Oil remained clear while under observation.
C. T.	40	10	1565	1825	7	No purulent exudate after 7 mo. Vegetable oil removed because of absorbability and refill given with sterile paraffin oil. No exudate for 1 yr. Case is now inhibition oleothorax.
O. C.	42	24	4260	3390	6	Purulent exudate disappeared after 3 mo. Oil withdrawn and pneumothorax again instituted. Purulent exudate again developed and exists at present time.
M. C.	33	14	1825	2355	3	No purulent exudate after 3 mo. All oil removed after 5 mo. Pneumothorax again instituted without return of exudate. 1125 c.c. of oil removed from pleural sac.
W. K.	24	12	1200	1200	2	Purulent exudate disappeared after 2 mo. treatment. Died of generalized tuberculosis after 1 yr. Autopsy showed no evidence of pyothorax. Pleura not unduly thickened.
F. J.	36	30	12250	5725	16	Purulent exudate changed to a seropurulent, then to a serous exudate. Exudate later became blood tinged. Since the fluid has been either serous or seropurulent, it has not responded well, due to the fact that the empyema was of long standing prior to instituting oleothorax.
W. H.	32	33	4125	5960	15	Tuberculous empyema. Patient has been under treatment for 16 mo. Has a large empyema cavity from which 440 c.c. in pus was removed in the beginning. Patient's general health has improved. Small amounts of pus are now removed once weekly. Case of long standing prior to induction of oleothorax.
B.L.C.	24	12	1735	2035	4	Tuberculous empyema. No purulent exudate after 1 mo. Case developed pus under observation for which immediate and energetic oleothorax therapy was induced. Gain of 12 pounds during treatment. Now has satisfactory compression of lower lobe, upper lobe collapsed by upper phase thoracoplasty.

In a few cases the dosage has been increased to 100 c.c. after the initial test dose, without harmful results. This may be attempted when a purulent exudate is already present; but should never be attempted in inhibition or compression types of oleothoraces. In empyema cases a systemic gomenol reaction can be treated by withdrawal of the oil, and the therapy reinstituted more cautiously without harm. The avoidance of the local or pleural reaction is not so important, as a pyothorax already exists.

INHIBITION OLEOTHORAX

Many pneumothoraces are unsatisfactory because of partially adherent lung or numerous pleural adhesions, and in such cases pleural exudation

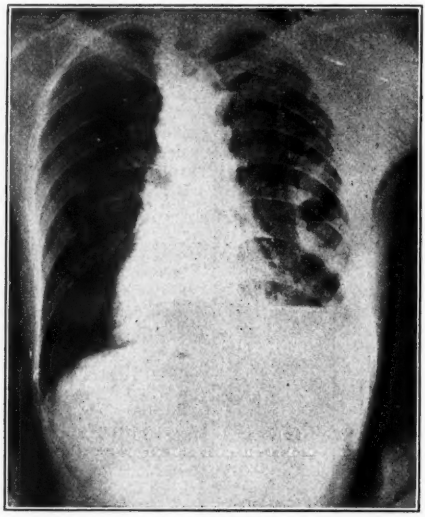

Fig. 3.—Illustrating obliterative pneumothorax just prior to oleothorax therapy.

is a frequent complication. The presence of the exudate, especially during the resorption stage, favors the formation of additional adhesions. Membranous partitions may form and subdivide the pneumothorax space into smaller pockets, encysting the exudate and making its removal difficult or even impossible. The pneumothorax cannot be maintained in such instances even by the most energetic attempt to do so. There is an obliterative pneumothorax which is of a progressive character, tending to complete obliteration of the space. The patient's outlook after lung reexpansion depends upon the character and extent of lesions in the lung as influenced by the duration of the lung compression. In general, the earlier the space becomes obliterated after the induction of pneumothorax, the more guarded the prognosis.

Oleothorax therapy of the inhibition type should be initiated immediately when the operator is convinced that he is dealing with an obliterative pneumothorax.

The case of C. A. given in Table II is shown in Fig. 3. Fig. 4 shows the case eighteen months after the induction of oleothorax. Fig. 3 is an excellent example of obliterative pneumothorax. In this case, as in our other cases of inhibition oleothorax, a phrenic exeresis was performed after complete oleothorax to produce added pulmonary compression.

Before the introduction of oil all pleural exudate should be removed. In this type of oleothorax it is of utmost importance to test thoroughly the pleural space for sensitivity to gomenol by carefully graduated doses

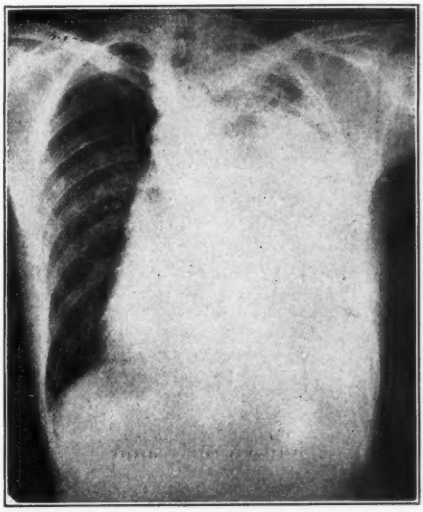

Fig. 4.—Same case of Fig. 3, eighteen months after the induction of inhibition oleothorax.

prior to larger refills. Even with the greatest care, an occasional case will show the complication of purulent exudation. All cases require the closest observation possible in order that purulent exudation may be detected early, and proper treatment instituted. This observation consists of clinical study, frequent x-rays, and diagnostic thoracentesis at frequent intervals. Purulent exudation casts a denser shadow than oil on the film and may be detected in this manner. Fig. 5 illustrates the differences in density of the two substances.

Purulent exudation is a dreaded complication and one to be avoided; but early recognition of its presence and early energetic treatment by disinfection oleothorax will usually result in disappearance of the purulent exudate within a few weeks or months. This is probably the most severe complication of the therapy, and is in most instances not as

serious as that of an early lung reexpansion. In instances of obliterative pneumothorax occurring early in artificial pneumothorax, the induction of an inhibition type of oleothorax may prevent the resort to a more radical type of surgical collapse.

Table II consists of brief data concerning 6 cases of obliterative pneumothoraces treated by the inhibition type of oleothorax. Five of these cases have had no complications. One patient developed the complication of purulent exudation, which was further complicated by a pleurocutaneous fistula. In all 6 cases a satisfactory degree of compression has been maintained with clinical improvement.

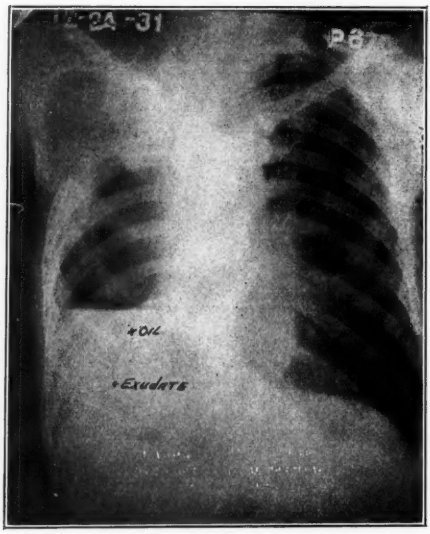

Fig. 5.—Illustrating the difference in density of oil and purulent exudate, as shown by x-ray plate.

Inhibition oleothorax was induced, using 5 per cent gomenolized vegetable oil, except in 2 instances. One patient was treated with 5 per cent gomenolized paraffin oil and another with sterile paraffin oil without the addition of gomenol. In the 4 cases in which vegetable oil was used, refills were given with mineral oil, as absorption of vegetable oil made refills necessary. The rapid absorption of vegetable oil in certain cases makes its use in the inhibition type of oleothorax objectionable. We advocate the use of the rather nonabsorbable paraffin oil in such cases, and since an antiseptic quality is not essential, it is believed the substance of choice is 1 per cent gomenolized paraffin oil.

TABLE II

INHIBITION OLEOTHORAX IN OBLITERATIVE PNEUMOTHORAX

NAME	AGE	NO. TREATMENTS	TOTAL AMOUNT EXUDATE REMOVED IN C.C.	TOTAL AMOUNT OF OIL USED	DURATION OF OLEOTHORAX IN MONTHS	RESULT
G. M.	30	14	None	2420	18	Unsatisfactory pneumothorax, unable to maintain space, for which oleothorax was substituted. No complications. Satisfactory compression.
C. A.	36	13	300	1980	19	Unsatisfactory pneumothorax, numerous adhesions complicated by pleural exudate (clear) with early and rapid obliterative pneumothorax. Febrile reaction to several treatments but never presented purulent exudation. Oil is being gradually removed.
R. Mc.	29	10	600	1220	12	Artificial pneumothorax was soon complicated by clear pleural exudation with definite evidence of obliterative pneumothorax. Oleothorax instituted for inhibiting reexpansion of the lung. No complications. Satisfactory compression.
E. M.	39	18	1800	1600	7	Case of bilateral pneumothorax with the complication of obliterative pneumothorax on one side. Inhibition type of oleothorax instituted, followed by the complication of a purulent exudate after 4 mo. Now being treated by disinfection oleothorax. Case complicated further by pleurocutaneous fistula.
F. P.	29	16	1050	1640	13	Obliterative pneumothorax with serous exudate. Exudate removed repeatedly. Oleothorax instituted using 5% gomenolized vegetable oil, using paraffin oil for refills. Marked clinical improvement.
F. H.	26	4	None	750	3	Partial pneumothorax with patent cavity from which he continued to have hemorrhage. Oleothorax, using paraffin oil, was induced, using moderate pressure. Hemorrhage ceased and there was clinical improvement.

Remarks: The total amount of oil administered in cases listed in Tables I and II is far in excess of the amount actually in the chest at any given time. This is due to the fact that oil is removed in varying quantities at each aspiration.

DISCUSSION

Our discussion deals with highly favorable results in 15 cases of oleothorax, a rather small series to be of a conclusive nature. Results, however, have been so far superior to other methods of treatment of tuberculous empyemas that we enthusiastically advocate disinfection oleothorax therapy as the method of choice. Some authors doubt whether or not gomenol has any special value as a disinfection agent, and state that equally satisfactory results may be obtained by aspirations alone. This has not been our experience, as cases treated by gomenolized oil responded more readily both as to general improvement, and as to disappearance of the purulent exudate. It is believed that oleothorax therapy brings about a more energetic attempt to clear up the empyema. Aspirations are frequently followed by refills of fresh gomenolized oil, bathing the tuberculous serosa with oil, possessing at least a slight antiseptic quality. During this treatment, instituted primarily to rid the pleural space of tuberculous exudation, the lung is maintained satisfactorily compressed with little or no variation as to degree. As the oil preparation is less absorbable than air, the compression status of the lung is more constant.

Oleothorax therapy, in the vast majority of cases, prevents a resort to a more radical type of chest surgery, since this type of therapy energetically carried out and in a skillful manner will eradicate the tuberculous empyemas.

In speaking of oleothorax Matson states, "Certain it is that oleothorax therapy requires far more technical skill, keener judgment in the selection of material, and closer observation of cases than is required in artificial pneumothorax therapy." This statement is especially true of inhibition oleothorax. In this type of therapy one is apt to encounter the complication of tuberculous empyema. Since tuberculous empyema responds satisfactorily to early energetic and a skillfully conducted disinfection oleothorax, the complication proves to be one not so serious in character. The precaution is to induce the inhibition type cautiously and follow the case with the closest observation. The observation must include frequent diagnostic aspirations to detect, at the earliest moment, the presence of purulent exudation.

Obliteration of the pneumothorax space during the earlier months of treatment, if not inhibited, may spell disaster unless radical surgical collapse is employed. Reexpansion of the lung in obliterative pneumothorax may be inhibited by the induction of oleothorax.

Our results in cases so treated have been entirely satisfactory in most instances. Complications in one instance, while grave in character, were probably less serious than they would have been with an untimely lung reexpansion. In the 5 other cases there have been no complications and sufficient lung compression has been maintained.

CONCLUSION

1. Tuberculous empyema complicating artificial pneumothorax is often the result of a small superimposed spontaneous pneumothorax as determined by fluoroscopic observation.

2. The superimposed spontaneous pneumothorax may be due to a rupture of a subpleural tubercle or from the rupture of air cells resulting from spontaneous ruture of a smaller adhesion.

3. In either event sufficient tubercle bacilli may be expelled into the pleural space to produce finally a purulent exudation; however, it is recognized that the condition usually follows cortical tuberculosis.

4. Tuberculous empyemas in most instances respond readily to oleothorax therapy, using 5 per cent gomenolized vegetable oil (Mazola). Its use is enthusiastically recommended.

5. Evidence of obliteration of the pneumothorax space in the earlier months of pneumothorax therapy demands the institution of some type of therapy to inhibit lung reexpansion. Inhibition oleothorax using 1 per cent gomenolized paraffin oil is advocated in these cases.

REFERENCE

1. Matson, Ray W.: Am. Rev. Tubere. 25: No. 4, April, 1932.

INTRATHORACIC DERMOID CYSTS AND TERATOMATA WITH A REPORT OF SIX PERSONAL CASES AND 185 CASES COLLECTED FROM THE LITERATURE

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CONGENITAL cystic tumors that contain epidermis or some of its constituents are usually called dermoids or epidermoids; those showing also derivatives of the mesoderm are variously described as dermoids or teratomata, while those containing derivatives of all three germinal layers are usually designated as teratomata, but some of them have been classified as fetus in fetu. The common feature of these growths that distinguishes them from all other tumors is the presence of epidermis or its products. Most of them are cystic but a few are essentially solid. Their exact genesis is not known. As Heuer suggests the best inclusive term for the whole group in the present state of our knowledge of them would seem to be "dermoids."

PATHOGENESIS

There are two fundamentally different hypotheses as to their embryologic origin; namely, the monogerminal and the bigerminal. The monogerminal hypothesis implies the development of all types from the same embryo; the bigerminal that there may be a second independent embryonal anlage which does not reach normal body form or structure but remains as a parasitic fetus in fetu. The origin of this secondary anlage is held to be either a fertilized polar body or a blastomere which has become independent and which then undergoes varying degrees of development in different cases (Marchand-Bonnet). Some writers believe that only the more complex teratomata are of this bigerminal origin, others hold that a unilateral teratoid development cannot be excluded for the whole group (Ewing).

The monogerminal hypothesis accounts for all types and grades of tissue differentiation on the basis of a separation or segmentation and inclusion of cells from the oral stoma in the gastrula stage of the embryo or from later inclusions, the morphologic differentiation of which depends on the stage in the embryo at which the separation occurs (Schwalbe).

The bigerminal theory seems to furnish a satisfactory explanation for the teratomata, particularly those that possess rudimentary parts of organs and some semblance of body form, but teratoma vary greatly in degree of complexity and tissue constituents, and there is no other sharp dividing line between them and the simpler dermoids.

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Read before the Sixteenth Annual Meeting of the American Association for Thoracic Surgery at Washington, D. C., May 9, 10, 11, 1933.

The monogerminal theory accounts for all grades of complexity on the same basis. Budde has made a searching study of all types of maldevelopment including the most completely developed fused twins, and of imperfectly developed parasitic inclusions and monstrosities as well as of teratomata and dermoids. On the basis of this study he classified these conditions into:

1. Undoubted parasitic dependent forms.
2. Teratomata of "embryomorph" and "embryoid" types.
3. Local tumor-like developments (dermoids).

He states that the first group are of undoubted bigerminal origin; that the second and third are of monogerminal origin and that the distinguishing characteristic of the bigerminal parasite is that it is never subcutaneous with respect to the host and that it always shows metameric segmentation. None of the intrathoracic teratoma so far reported has possessed definite vertebral formation or segmentation and all complex teratomata have been intrathoracic.

The topographic distribution of these lesions anteriorly is in keeping with the monogerminal hypothesis. In the definitely recognizable vertebrate fused twins the point of fusion is various.

The probable origin of a large proportion of the intrathoracic dermoids is thought to be in the region of the branchial clefts where the embryonal anlagen are subject to very considerable involution—the abnormal cellular inclusion being carried into the anterior mediastinum with the descent of the heart (Minot). Scammon has pointed out the probable embryologic relationship of the precervical sinus to their formation. A definite pedicle attached to the upper mediastinum has been frequently found even in cases with large tumors situated low and laterally. A close association with the thyroid has been observed in a few cases (Marchand, Collenberg). In Collenberg's case there was a pedicle from the dermoid containing branches of the thyroid artery and vein. A few have been attached by fibrous tissue to a persistent thymus (Pinders, Hattori). In some instances the origin from lower down is suggested by the presence of a supersternal as well as a substernal cyst communicating by a narrow channel through the sternum (Bergman, Bird). A number of extrathoracic sternal dermoids have been observed. (Andolay collected the first 7 reported cases.) Others have been reported by Selby, MacEwen, Chilton, Cahen, Calvalcanti, Morestini, Bird. These are here excluded as extrathoracic.

INCIDENCE

The ancient literature contains several references to the finding of a heart covered with hair (Godfrey) and also to the findings of hair in the blood. The first authenticated case of intrathoracic dermoid is that of Gordon in which hair and teeth were found at necropsy in a tumor presenting in the suprasternal notch. A careful survey of the literature

up to April, 1933, reveals 185 verified by the finding of epidermis, hair or cholesterin crystals and sebaceous material in combination in the sputum, aspirated fluid, in discharges from draining sinuses or at operation or necropsy. References to all these cases is found in the appended bibliography. These with the 6 personal cases make a total of 191. Those diagnosed on the basis of other clinical and on roentgenologic studies are excluded as unverified. A few instances of simple cysts lined with ciliated columnar epithelium reported as dermoids are also excluded. Some of them may be true dermoids but most are probably of other origin. Rarely the epidermis may have entirely desquamated leaving only the single malpighian layer (Christian), or may have disappeared entirely as in the instance of a calcified cyst reported by Heuer. The presence of cilia indicates an intact epithelium.

In this study reference has been made to series of cases previously reported by Riegel, Köerte, Dardignac, Pflanz, Ekehorn, Dangschat, Roger, Morris, Nandrot, Hertzler, Auroussean, Kerr and Warfield, Heuer, Kaestle and others but with very few exceptions the original case reports have been reviewed.

SEX

Seventy-nine were males; ninety-two females; in case of twenty the sex was not given.

The age incidence at the time of observation, operation or necropsy was as follows:

AGES	CASES
Under 12 years	26
12 – 16	13
17 – 20	28
21 – 30	64
31 – 40	21
41 – 50	11
51 – 60	8
61 – 70	1
Not stated	16
Total	191

The ages of the 22 children under twelve were as follows: three to four months, 4; six months, 1; eight months, 1; one to five years, 6; six to twelve years, 10.

Eighty-six died untreated; ninety-nine were operated upon. Six patients were either living untreated or their bodies were not examined after death.

PATHOLOGIC ANATOMY. LOCATION

Almost without exception intrathoracic dermoids lie anteriorly or anterolaterally. Only as they enlarge do they project backward. Duval has classified them into four groups (1) retrosternal, lying between the mediastinal pleurae and behind the sternum; (2) cervicoretrosternal,

presenting in the suprasternal notch or from behind one sterno-clavicular joint; (3) mediastinothoracic, extending into either thoracic cavity and (4) lateral thoracic, lying largely in either thoracic cavity. Clinically this classification can be used accurately only in case of small retrosternal and cervicoretrosternal tumors. The borderline between the sternolateral and lateral, as described in case reports often is not definite. The base of the tumor in the retrosternal groups is above the upper half of the sternum. The mediastinothoracic and lateral may occupy any portion of the anterior thoracic cavity. According to Duval's classification the location of the tumor in 176 cases in this series was as follows:

LOCATION	CASES
Retrosternal	13
Cervicoretrosternal	19
Sternolateral or lateral	144
Total	176

In the cases of Krause, Von Török and of Smith the tumors were said to be posterior. In a number there was a projection into both pleural cavities. The tumor was inside the pericardium in the cases of Joel and of Grimm, impossible to identify from pericardium in Mouat's and arising from the diaphragm in my Case 5.

Among 116 cases in which the tumor was sternolateral or lateral it was on the right side in 63 and on the left in 53.

SIZE

The tumor was described as small (from the size of a pigeon's egg to that of a goose egg or apple) in 29; moderate sized (that of an orange or large fist) in 35 and large (from the size of a fetal head or coconut to that of a man's head) in 36. Among the largest definitely measured were those of Harris which weighed 2860 grams; Becker and Carey's which measured 30 × 20 × 10 cm., and weighed 4350 grams; Schliers' had a capacity of 4 quarts; Bendz' weighed 6360 grams and Christian's 4750 grams. The tumor weighing 669 grams in my Case Number 1, that of a child weighing 27 pounds, was among the largest in proportion to body weight. In case of one reported of a weight of 10 pounds and another of 1100 grams it is not clear how much of the fluid came from the cyst and how much from the pleural cavity.

RELATIONS AND ADHESIONS

The relation of the cyst or tumor naturally varies with its position. The degree of adhesions varies, being greatest usually in those cases with associated infection but in some of these it shelled out readily while in some cases without infection it was inseparable from some of the surrounding structures. A definite pedicle was described in a minority.

Among the cervicoretrosternal tumors firm adhesions were described to the sternum in 4, to the pericardium in 5, to the great vessels in 8, to the esophagus in 3, to a bronchus in 1, to a persistent thymus in 3. Among the sternolateral firm adhesions were found to the mediastinum in 12; great vessels in 19; pericardium in 19; diaphragm in 10, esophagus in 1; to the lung in 23; to the auricle in 2; to the trachea in 2 and to the vertebra in 2.

STRUCTURE

For purposes of description the tumors are here classified as epidermoids when containing only derivatives of the ectoderm; as dermoids when containing tissues of both ectodermoid and mesodermoid origin, and as teratoma when microscopic examination showed the presence of tissues derived in part also from the entoderm. Tumors reported as containing cartilage, bone and teeth but not examined microscopically are listed as dermoids. One hundred and eighty-four cases in the series are classified as follows:

	CASES
Epidermoid (microscopically examined)	42
Epidermoid (not microscopically examined)	54
Dermoid (microscopically examined)	40
"Dermoid" (not microscopically examined)	10
Teratomata (microscopically examined)	38
Total	184

The typical epidermoid cyst consists of a cyst wall composed of an outer fibrous layer and an inner one of stratified squamous epithelium with a stratum corneum with or without glandular tissue of ectodermal origin. Tissues showing differentiation characteristic of brain and nerves and retina have been found as far as recognizable, only in the presence of mesodermal or mesodermal and entodermal structures. The typical cyst content consists of secretions of the glands and desquamated epithelium with or without cholesterin in the form of a watery, sirupy, gelatinous or pasty, clear, milky, yellowish or brownish material, often mixed with hair, which may be found singly or in nests. Degeneration changes may greatly alter the typical histologic findings. Some or even all of the cellular epidermal elements may have disappeared leaving only hair as a certain identifying structure. In a very few instances sebaceous material and cholesterin crystals are probably of other origin than epidermoids.

The dermoid cysts are differentiated from the epidermoid by their content of tissues of mesodermal origin such as cartilage, bone, teeth, smooth or striated muscle and blood vessels, in addition to ectodermal structures. These tumors are usually lobulated or multicystic, lined with stratified epithelium but usually presenting areas of thickening in the cyst walls often nodular or polypoid and containing the mesodermal

elements in these regions. Some of the smaller of multiple cysts have been found to be lined with a single layer of epithelium, at times ciliated. The contents may be similar to that of the epidermoids.

The teratomata are usually multicystic and may be more or less solid. They may contain in varying combinations tissues derived from the digestive tract with associated glands, respiratory tract, thyroid and thymus. One of the most common entodermal constituents in these teratoma is tissue resembling pancreas, present in 9 cases, intestine in 7, stomach in 4, liver in 4. What resembled respiratory tract epithelium was present in 6; ovarian and tubal in 1; splenic in 1; uterine in 1.

In several of these teratoma organized arrangements of the tissues was suggested. In one there were several coils of small intestine (Von Török). Several had an outside covering of skin and in one there were upper and lower appendage-like structures with tissues resembling in arrangement and structure tube, ovary and vagina (Wilcox and Wollstein). Bony structures suggestive of an alveolus with teeth and other bone formations have been repeatedly observed, but in no case definite vertebral segmentation.

COMPLICATIONS

These include chiefly rapid enlargement of the tumor from unknown cause, perforation, infection and malignant degeneration.

Abrupt rapid increase in size of the tumor has been repeatedly noted. In Case 1 herewith reported there was a rapid enlargement of the tumor as visualized in repeated roentgenograms during a period of 4 months, when the tumor had become so large as to almost asphyxiate the child. Hertzler believes this abrupt enlargement is due to an irritation of the tumor, probably chemical in nature, that produces an increase in the fluid content and an irritation of the environment resulting sometimes in a pleural effusion. In a number of instances such a change seemed to have been initiated by trauma. The fluid in such cases is usually sterile.

Infection of the cyst may result from influenza or pneumonia or other intercurrent infection or from aspiration, incision or spontaneous rupture of a cyst into a bronchus or through the skin. In this series a bronchial fistula was evidenced by coughing up of hair in 26 cases. In several others in which there was a bronchial fistula and hair found at necropsy or operation it could not be coughed up because it was in the form of a hair ball or nest. Spontaneous rupture of the cyst in the neck is reported by Gordon and by Raspail and on the chest wall by Koerte, Mandelbaum, Goebel and Ossig and in my Case 4.

In a few instances the cyst has ruptured into the pleural cavity producing a condition simulating an empyema. More often the cyst has been incised under the mistaken diagnosis of empyema. Rupture into

the pericardium is recorded by Cordes, and by Masson; into the aorta by Buchner; into the superior vena cava by Stein.

Malignant degeneration in the nature of carcinoma, sarcoma, chorio-epithelioma and tumor of uncertain type was found in 17. The cases in which this occurred is indicated by a double asterisk in the bibliography. In 8 there were metastases to other organs.

SYMPTOMS

The onset of symptoms was insidious in about three quarters and abrupt in one quarter of the cases in which the mode of onset could be judged by the clinical history. In many cases the condition was symptomless and was discovered by routine physical or roentgenologic examination. The duration of symptoms to necropsy or operation in 100 cases was under six months in 37; 6 months to one year in 22; one to five years in 34; five to ten years in 18. The initial symptom or sign in 85 cases was dyspnea with or without cough in 18, pleurisy with or without effusion in 15, pain in chest in 11, swelling in neck or chest 10; symptoms of pulmonary tuberculosis 9; pneumonia 6; other initial symptoms were palpitation "pressure symptoms," "flu," spitting up hair with pus or blood and in one instance paralysis of the right arm.

The most common presenting symptom was cough present in 87. There was sputum more or less purulent in 38, and foul in 10 of these. Hemoptysis was present at some time in 26, in some cases of severe grade. Hair was coughed up in 26. In a few "oily," "fatty" or "sebaceous" material and cholesterin crystals were noted in the sputum. In one instance (Medoci) pieces of cyst wall were said to have been coughed up. Pain was noted in 46; dysphagia in 5; hoarseness in 8; orthopnea in 5, palpitation in 6.

The most common physical finding was dullness or flatness to percussion anteriorly, with or without distant or absent breath sounds, noted in 74 of the cases. Bulging of the chest was observed in 33 with fluctuation in 5 and with pulsation in 3, bulging or tumor in the neck in 19 with pulsation in 3 and with a sinus present in 2. Edema of one or both arms and in some, of the face, was noted in 12; enlarged veins in the chest or neck in 11; cyanosis in 18; other pressure symptoms in 7. Among other symptoms occasionally observed were marked weight loss in 12; heart displacement in 7; enlarged pericardium in 4; "pericarditis" in 8; unequal radial pulses in 1; kyphosis in 2. Findings of pleurisy with or without effusion were made in 20, empyema in 7. Of other unusual findings may be mentioned spontaneous sinuses of the chest wall or neck in 3, secondary collection of fluid in flank (Greisshammer), extreme weakness and succussion splash (Opokin). Tuberculosis was diagnosed in 10 and in one with tubercle bacilli in sputum. In several others necropsy showed pulmonary tuberculosis in addition to dermoid.

ROENTGENOLOGIC EXAMINATION

The typical anteroposterior roentgenologic plate in an uncomplicated case shows a circumscribed well-outlined shadow, the base of which fuses with the mediastinal or cardiac shadow, the rounded edge projecting laterally (Fig. 1). The oblique or transverse view shows the shadow to be anteriorly situated (Fig. 2). In case of a small retrosternal tumor a shadow may be detected only on a laterally or obliquely taken plate. A cervicoretrosternal tumor will produce a shadow in the upper mediastinal region and in the neck. Rarely areas of increased density suggesting calcification or bone have been observed

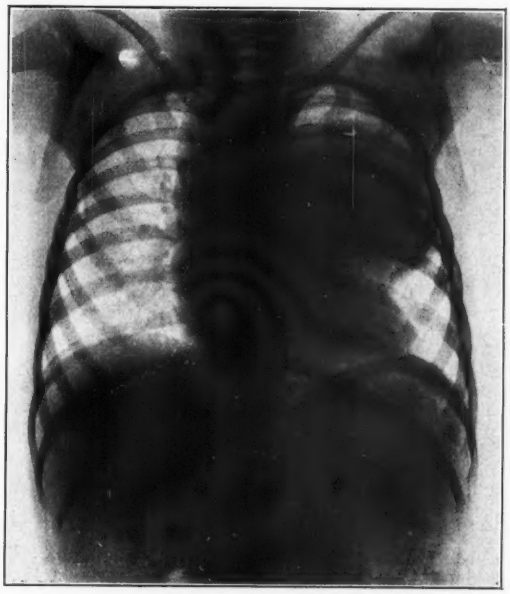

Fig. 1.—J. G., aged three and one-half. Roentgenogram four months before operation showing the shadow of dermoid cyst with the mediastinum displaced somewhat to the right.

(Smith and Stone, Kleinschmidt, Goebel and Ossig). In exceptional cases (Steinmeyer) a dermoid is located entirely laterally and in such a case produces a shadow distinct from the heart and mediastinum. The differentiation of dermoids from other tumors, echinococcus and other cysts cannot be made with certainty on the basis of the roentgenographic examination alone. Fluoroscopy is useful in differentiating aneurism but dermoids have been diagnosed as aneurism and aneurism as dermoids (Hale), (Heuer). Pneumoperitoneum was used by Moon to exclude an abdominal tumor. Lipiodol bronchography may be of value in demonstrating the presence of a bronchial fistula and bronchial occlusion.

Perforation of the dermoid into a bronchus or pleural cavity or an associated pleuritis or pericarditis with effusion will produce changes in the roentgenologic picture suggestive of these conditions and may entirely obscure the picture. In my Case 5 there was an intrapleural collection of fluid through which irregular denser shadows were present.

DIAGNOSIS

Positive clinical diagnosis of dermoids rests on the demonstration of epidermal products—hair, squamous epithelium or sebaceous material in sputum or discharges from cutaneous sinuses.

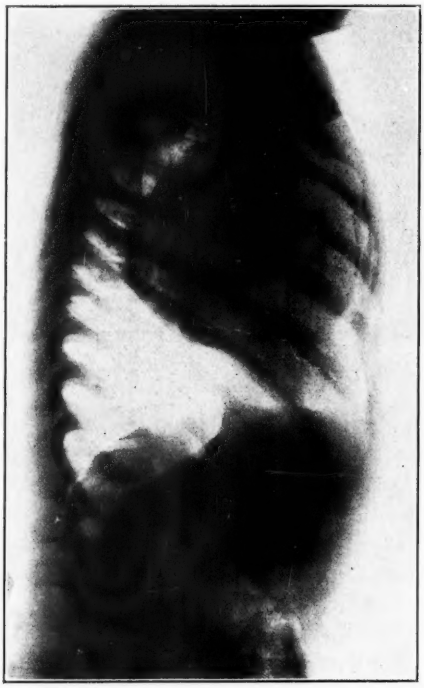

Fig. 2.—Same case as Fig. 1. Lateral view.

In an uncomplicated case a probable diagnosis of dermoid may be made on the basis of the presence of irritative and pressure symptoms as outlined and with the physical and roentgenologic findings characteristic of a tumor in the anterior mediastinum or pleural cavity. Gradual onset and long duration of symptoms and physical findings beginning in early adult life are characteristic but it is important to bear in mind that the onset may be early in life, abrupt and of rapid course (Case 1). The differential diagnosis includes chiefly cysts of other na-

ture, including echinococcus, encapsulated effusion, substernal goiter, aneurism and cold abscess, malignant and benign tumors. Among these, malignant tumors are the most important from the standpoint both of prognosis and treatment.

An exploratory aspiration may be of distinct value in the differentiation of these conditions including aneurism and probably involves no considerable risk except in case of echinococcus cyst following the aspiration of which several deaths have been reported. The possibility of echinococcus infection is suggested by the history, by the presence of eosinophiles and by a positive complement fixation test (Casoni Test), but it may be misleading as in case of a dermoid reported by Bugliarello. The presence of a high fat cholesterin and protein content in aspirated fluid is suggestive of dermoid (Singer). Rarely hair may be aspirated (Harris). Microscopic examination of the sediment may reveal fragments of squamous epithelium in case of dermoid or cells suggestive of malignancy which does not necessarily exclude dermoid as it has been shown that malignant degeneration occurs in about 10 per cent of the cases.

Biopsy on the tissue from the cyst wall may be of value in excluding malignant tumors as in my Case 1. Here the rapid growth strongly suggested malignancy, which, had it been found at biopsy, would have been considered as definitely contraindicating radical operation. Radiotherapy was also used in this case as a therapeutic test of malignancy.

In the complicated cases with perforation and infection simulating empyema, pulmonary abscess, pneumonia, pleural effusion, tuberculosis, or pericarditis, the diagnosis of the underlying dermoid has been made usually by the unexpected characteristic findings in sputum or aspirated effusion. In a large number of cases the diagnosis has been made during operation for empyema by the finding of hair in the cavity, or in a few cases by microscopic examination of excised parts of the cyst wall. A considerable number, particularly of the earlier reported cases, have been unexpected necropsy diagnoses.

PROGNOSIS

The outlook without treatment depends on the location, size and growth of the tumor and on the intercurrent infection and the chance of malignant degeneration. In a few instances the tumor has remained small and symptomless and has been found unexpectedly at necropsy. In a great majority pressure symptoms, infection or perforation occurs. When the patient is seen with such manifestations the outlook without treatment is not good. The prognosis for operative extirpation also depends in considerable measure on the location and extent of the tumor and on complicating conditions and also on the anatomic relationship and on the degree of adhesions which may make complete extirpa-

tion a very difficult and formidable operation. A several stage operation is a factor of safety in some cases.

TREATMENT

Radical extirpation without drainage before pressure symptoms have supervened and before infection is the ideal treatment. Exceptionally adhesions to the great vessels may be too firm and extensive for complete excision but if all the epithelium can be removed by sharp dissection or by judicious cautery, a cure may be expected. The relative indications for extirpation of a symptomless tumor in the presence of other conditions unfavorable to operation is a matter of judgment. If operation is delayed until after the development of severe dyspnea, cyanosis, and other symptoms of severe mechanical embarrassment, it may still offer the only hope, but its hazards are then greatly increased. In such cases aspiration of cystic contents may be attempted and the removal of associated pleural effusion may effect some temporary relief.

In the presence of findings suggesting an intrathoracic tumor or encapsulated effusion the probability of a dermoid should always be considered and if a cyst is found at exploratory thoracotomy its excision should be attempted. Drainage in such cases inevitably results in infection which increases the immediate risk and adds greatly to the hazards and difficulties of later radical extirpation and secondary plastic operation may be necessary for obliteration of the empyema which usually results. In a considerable proportion of the reported cases the cyst was drained at the first operation under the false diagnosis of empyema.

In the majority of the cases infection was present at the time radical operation was undertaken. Such infection usually resulted from perforation of the cyst into a bronchus or into the pleural cavity. Such cyst contents may be infected at the time of perforation or in some it became infected later incident to an intercurrent pneumonia, tonsillitis, etc. Infection probably precedes a spontaneous rupture through the skin. Such complications presenting the clinical picture of a pulmonary abscess or of an empyema or of both, may constitute the first indication for treatment. Removal of an infected retrosternal dermoid results in a draining abscess, that of a sternolateral dermoid approached through the pleural cavity in a localized or generalized empyema. If the pericardium is opened there is serious risk of a purulent pericarditis.

The surgical approach to an uninfected dermoid varies according to its location and size. A cervicosternal dermoid, if small, is reached most simply and safely through a transverse cervical incision as for removal of a substernal goiter. If it is large and adherent, splitting or resecting the upper sternum may be necessary. An adequate exposure so provided is a factor of safety against hemorrhage and injury to the pleurae in case the dermoid is densely adherent or very large.

Among 15 reported cases of cervicoretrosternal dermoid subjected to operation the approach was through a cervical incision in 11, with a trephine of sternum for counter drainage in two, and with resection in one, and splitting of the sternum in one. Five were drained only. Of these 4 were improved but had persistent fistulas and one died. The cause of death was not stated. The dermoid was partly removed in 3. Two were cured and in the case of one a fistula persisted. Complete extirpation was effected in 7 with eventual complete cure in all. Among these was the case of Bastianelli, the first complete extirpation of a dermoid cyst resulting in a cure.

Among 5 strictly substernal dermoids the sternum was trephined in two with counter drainage. One was unimproved; in the case of the other the result was not stated. In case of one a sternal "window" was made. The cyst was found adherent to the innominate vein and could not be removed. The patient died. The cause of death was not stated in the report.

The tumor was partly removed in two. Both patients were cured.

Among 79 dermoids situated sternolaterally or laterally 14 were drained only; partial excision was effected in 20 and complete extirpation in 45.

Among the 14 that were drained, only the transpleural approach was used in all with the additional resection of the sternum in one. In case of 4 patients a two or three stage operation was performed. None was cured. Six were improved but had persistent bronchial fistulas. One of these patients died about three months later of hyperthyroidism (Case 5). One had a severe hemorrhage following the operation and was discharged unimproved. Six died, one on the second day, one on the tenth day, one a few weeks after operation. The cause of death was not stated. One died of pneumonia, a few months after drainage, one who had a complicating malignancy died of hemorrhage after a few months; one lived four years. The result in one case was not stated.

Among the 20 patients in case of whom the dermoids were partially excised, the transpleural approach was used with resection of the sternum in 3. Several had a two or three stage operation. Three were cured, 14 were improved but had persistent fistulas, and 3 died. In case of one of the patients who was cured two plastic operations were necessary involving a transplantation of the breast for obliteration of the cavity (Moon). There was a complicating mediastinitis besides empyema in one (Heuer). Among the 14 who were improved, one died one year later of carcinoma (Singer) and one two years later of hemoptysis incident to pulmonary tuberculosis.

Plastics for the obliteration of a residual empyema was performed in several. In one case (Shaw) cauterization of the dermoid was performed in 10 sittings.

Among the 3 postoperative deaths, one was from pericarditis due to rupture of the dermoid into the pericardium before operation (Moon) and two from pneumonia.

Complete extirpation of the dermoid was performed in case of 45 patients. In 3 cases (Duval and Clarc, Bull, Hedblom) a rib spreading incision was used without section of rib or cartilage and the wound closed without drainage and with complete cure after a short convalescence in all. In case of all the others resection was performed of one or more ribs and with resection of the sternum in 5. A two or several stage operation was performed in about half the cases. In case of several the tumor was removed piecemeal in several stages (Lilienthal, Davies) and in a number several plastic operations were performed for obliteration of the residual empyema. In several instances the breast was used for obliteration of the cavity and in case of one the pectoralis major.

Of the 45 patients 31 (71 per cent) were cured, 5 were apparently rendered symptom-free except for a persistent fistula. One of these died after 4 months of empyema. Seven died (15.5 per cent).

Schmeiden reports that in his successful case the vena cava and pericardium were both opened and repaired at operation. Robertson states that in one of his cases in which he used a trapdoor across the sternum both pleural cavities were opened. He successfully removed the tumor at a later sitting.

The cause of death in the 6 fatal cases was dyspnea and cyanosis immediately after operation in one, pericarditis in two; in one following accidental opening of the pericardial cavity during operation; pneumonia in two; hemorrhage from the mammary artery following cauterization in one, pneumonia during the third week in one. One died four months after operation, the cause of death not stated.

Summarizing the results, it is thus found that of 99 patients subjected to operative treatment about 47.4 per cent were cured, 32.3 per cent improved, the chief persisting condition being a draining sinus, and 16.1 per cent died.

Of my own 6 cases 4 were completely cured by radical extirpation of the dermoid, one was unrecognized as such until necropsy following death from hyperthyroidism, and one died of pneumonia following preliminary drainage operation.

By far the most important cause of both an imperfect result and of death in the whole series was infection present at the time of operation.

CASE 1.—J. G., a three-and-one-half-year-old girl, referred by Dr. C. K. Jones, was admitted to St. Luke's Hospital March 24, 1931, because of a persistent unproductive cough, dyspnea, and fever. From the onset the cough had been paroxysmal, some spells lasting five minutes or more. A month before admission she had a sore throat for which Dr. Jones was consulted. Roentgenogram at that time showed a shadow occupying most of the upper left lung field, with displacement of the heart

to the right. (Fig. 1.) During the last days before admission she had been noticeably short of breath and the cough had assumed a harsh character. Fever had been present for three days. She had been a normal full-term baby and had had three attacks of pyelitis at intervals of about one year and had chickenpox at the age of four months.

She was frail and thin. The thorax seemed symmetrical at rest and during respiration. There was definite percussion dullness anteriorly from the second to the eighth interspace, continuous with the cardiac dullness and extending outward almost to the anterior axillary line. The breath sounds were absent over the area of percussion dullness. Posteriorly the physical findings were approximately normal

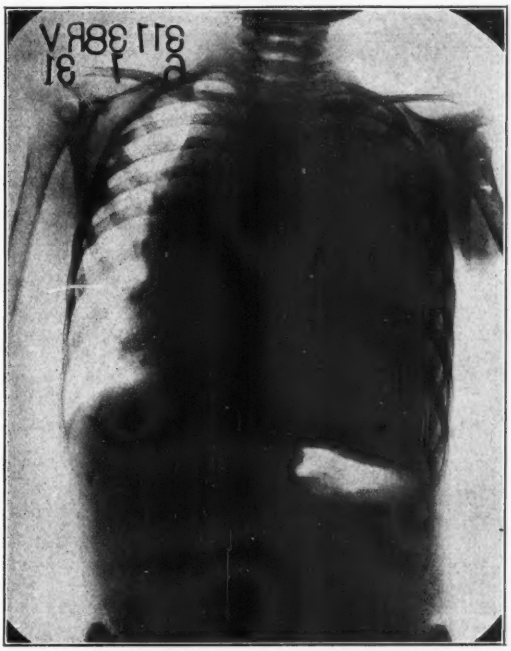

Fig. 3.—Same case as Fig. 1 eleven weeks later, showing shadow involving the whole left lung field. Diaphragm on left displaced downward and heart and mediastinum displaced markedly to right.

except that the respiratory fremitus was intensified along the vertebral border of the lung. A cardiac impulse was not elicited; the heart tones were rapid, but regular, and heard best over the sternum.

The urine showed normal findings except for a few leucocytes in the high power field. The hemoglobin was 82 per cent, erythrocytes, 4,350,000, leucocytes 14,750 with a differential count of 58 per cent lymphocytes, 34 per cent neutrophiles. There were no eosinophiles.

Roentgenologic examination (Fig. 1) showed a well-defined large shadow occupying most of the upper half of the left lung field, but with aerated lung below. A lateral roentgenogram (Fig. 2) showed the tumor in close contact with the anterior thoracic wall. There was no evidence of erosion of the bony structures. The costophrenic angles were clear.

The abrupt onset of symptoms and large size of the x-ray shadow suggested a rapidly growing malignant tumor rather than a dermoid. Symptoms of dermoid are uncommon at this age—having been observed in only 7 of 191 cases before the age of four years. An encapsulated effusion and cyst of indeterminate nature was also considered.

An exploratory aspiration in the anterior axillary line was performed on April 1 and about 80 c.c. of brownish fluid was obtained. On microscopic examination this fluid showed a few large mononuclear cells, erythrocytes and granular débris. Bacteriologic culture remained sterile. An attempt was made to aspirate more fluid to relieve the pressure symptoms but no more could be obtained. An attempt at radical extirpation seemed advisable only if malignancy could be excluded.

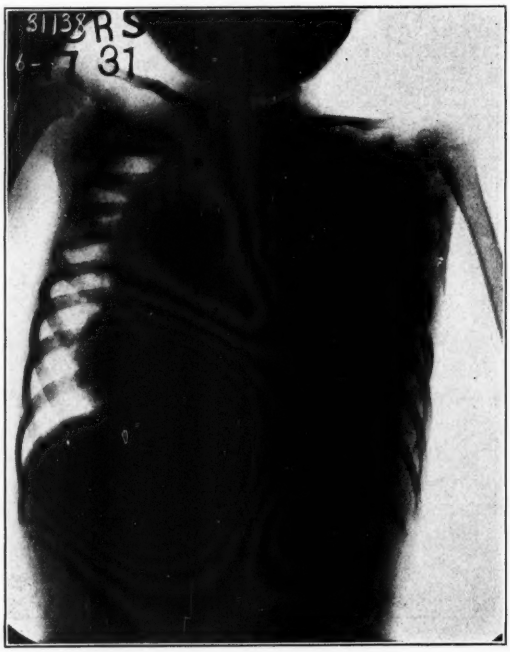

Fig. 4.—Roentgenogram taken ten days after that shown in Fig. 3. Note excessive displacement of heart and mediastinum to right. Patient almost in extremis.

For the purpose of biopsy a small intercostal incision was therefore made in the third interspace in the anterior axillary line. The tumor lay directly against the chest wall but was not adherent to it. A small segment of it was excised.

The histologic examination showed fully differentiated smooth muscle cells and fully formed and compactly arranged fibrous tissue indicative of a benign growth.

Surgical removal was therefore advised but because of the acknowledged risk in the patient's condition the parents elected to try radiotherapy first, in the hope that it might check the growth of, and possibly shrink, the tumor. During a period of two and a half months she received 8 treatments of 120 R units each, but her dyspnea and cough grew more pronounced and the roentgenogram showed a progressively enlarging tumor. (Fig. 3.)

When she reentered the hospital on June 16, 1931, she was very pale and dyspneic and had lost 5 pounds in weight. She weighed 28 pounds. She coughed a great deal, refused food and her sleep was restless and broken. Her pulse ranged between 120 and 140, respiration 30 to 48 per minute. At times she was definitely cyanotic. Operation was clearly the only hope of saving her life but she was already almost in extremis. A roentgenogram showed marked enlargement of the shadow and marked cardiac displacement. (Fig. 4.)

Operation was performed June 22, 1931. Under local and ethylene positive pressure anesthesia administered by Dr. Knowles, an incision was made in the fourth interspace from the sternum to the anterior axillary line curved around the region of the breast. The intercostal tissues and pleura were then incised without any rib resection. About 50 c.c. of turbid fluid escaped when the pleural cavity was

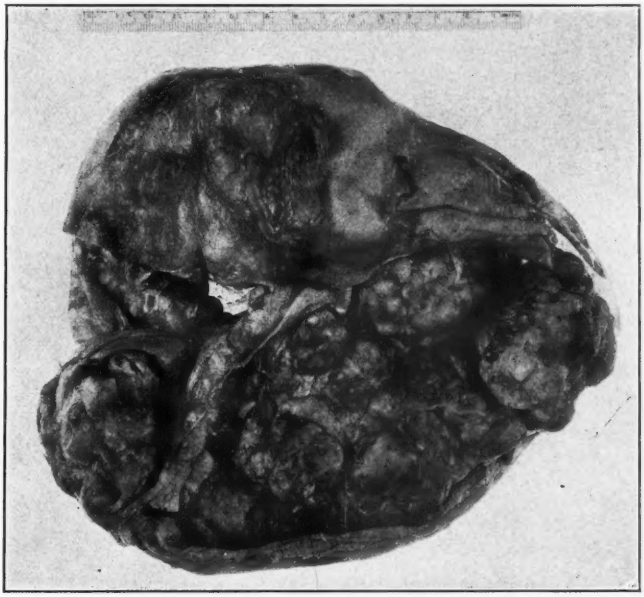

Fig. 5.—Photograph of tumor—weight 669 grams.

opened. The wound was enlarged by the use of rib spreaders without injury to the ribs. The tumor was about the size of the child's head (Fig. 5) and was adherent to the anterior chest wall, to the mediastinum and to the pericardium. It was greyish yellow in color and very firm. Adhesions were gently separated, at first anteriorly and laterally then from its mediastinal attachment where a fleshy pedicle about 3 cm. in diameter was clamped, cut and ligated and the tumor removed. During this procedure the pulse had risen above 160, respiration 44 and the patient was quite cyanosed. As soon as the tumor was enucleated the color improved. The left lung was compressed against the mediastinum along the vertebral gutter and showed no evidence of reexpansion even with gentle inflation through the gas anesthesia mask. Air bubbled from a small tear in the lung made in separating the tumor from it. This was repaired with catgut suture and several bleeding vessels were ligated. The wound was closed by interrupted catgut ligatures around the adjacent ribs, the intercostal tissue with a running suture, the muscle, fascia and skin with catgut,

silkworm gut and dermal suture. A needle was then introduced into the pleural cavity and 200 c.c. of air was aspirated which produced a less than atmospheric intrapleural pressure.

The patient left the operating table in fair condition, the pulse being 130 and the respiratory rate 36. A few hours later she was given 165 c.c. of her mother's blood intravenously and 600 c.c. of air was aspirated from the pleural cavity. She was no longer dyspneic and her pulse was of better quality than before operation.

The following day the pulse rate was 156, temperature 100.8°, the respiratory rate 40-50 per minute. On the second postoperative day 200 c.c. of air was aspirated.

On the 9th, 16th and 22nd day of her convalescence 800 c.c., 600 c.c. and 275 c.c. of air was aspirated from the pleural cavity, the manometer each time showing a positive reading before and a less than atmospheric pressure reading after the

Fig. 6.—Photomicrograph showing polypoid extensions of squamous epithelium and fully differentiated smooth muscles, ganglion cells and fibrous stroma underneath. Other sections showed cartilage, sweat and sebaceous glands and hair follicles.

aspiration. Her temperature which reached 103° on the 2nd day and the pulse rate which was 160 at that time gradually dropped and her general condition improved progressively. The wound healed per primam. She was discharged from the hospital symptom-free except for a somewhat rapid pulse July 19, 1931, 27 days after the operation.

This pathologic report by Dr. Hirsch was as follows: "This mass of tissue weighs 669 grams; its dimensions are 14 by 12.5 cm. by 8 cm. and it is nodular, and ovoid with a pseudocapsule torn in several places. Bulging through the pseudocapsule, that in places can be stripped back, are nodules up to 4 cm. in diameter and elevated above the surface 2.5 cm. In one place the capsule is torn in a region that exposes a surface 10 by 10 cm. and projecting from this rather flat surface are polypoid masses of yellow-white and red tissue up to 2.5 cm. in diameter. The surfaces of these masses are convexly rounded and portions have a finely mammillated

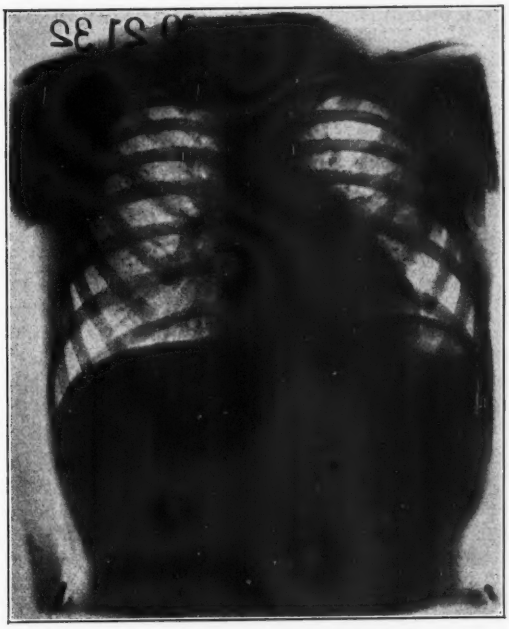

Fig. 7.—Roentgenogram sixteen months after operation for removal of cyst. Note heart is in normal position and absence of deformity. Cyst removed through a rib spreading operation.

Fig. 8.—Photograph of patient one year after operation.

yellow-white covering resembling the lining of an epidermal retention cyst. In the surface of some of these are tufts of light brown silky hair. Some of the yellow material on the surface can be scrapped away and is greasy. On surfaces made by cutting some of these nodules there is a firm fibrous tissue moderately edematous and like a nasal polyp, some yellow fat tissue and irregular plates of hyaline cartilage. There are deep crevices between the nodules but no regularity in their distribution.''

Histology: ''The small portions chosen for histologic examination have a multiplicity of tissues. The polypoid extensions are covered by squamous epithelium (Fig. 6) and beneath is a fibrous stroma of variable density fully differentiated and with bundles of smooth muscle as well as large masses of fatty areolar tissue, islets of ganglion cells, with some nerve fibers, simple tubules lined by columnar epithelium of the goblet cell variety and of the simple variety, islets of cartilage, sweat and sebaceous glands, and hair follicles. This conglomeration of tissue has no regularity or order in its arrangement except, of course, that the hair follicles and sebaceous glands are arranged in a corium-like tissue near the squamous epithelial margin.''

The patient gradually gained in weight and strength. Six weeks after operation breath sounds were heard posteriorly on the left side almost to the posterior axillary line, and anteriorly below the clavicle and close to the sternum.

Sixteen months after the operation she showed no symptoms or signs of any abnormality and was growing normally. The roentgenogram showed the heart to have resumed its normal position and the lung field on the operated side was entirely clear. (Fig. 7.) The thorax showed normal physical findings. (Fig. 8.)

Case 2.—L. B., a single American school-teacher of twenty-six years, referred to me by Dr. Harris of Battle Creek, Michigan, was admitted to the Augustana Hospital, October 17, 1926, complaining of dyspnea and constipation. Except for measles, mumps, chickenpox and whooping cough in childhood she had always been well up to the onset of her present illness.

In 1914, at the age of twelve she had an illness lasting 8 months, beginning with pain in the left chest, fever up to 104°, and dyspnea and weight loss. The attending physician made a diagnosis of pleurisy with effusion, but was not permitted to aspirate the fluid. Lying on her left side caused increased pain. There was no cough or sputum. All these symptoms subsided gradually and she had been quite well since except for an attack of ''influenza'' in 1918 and one in the spring of 1926, neither accompanied by pain or dyspnea.

May, 1925, during a routine physical and fluoroscopic examination, there were findings characteristic of a large left encapsulated pleural effusion and a partial dextrocardia.

At the time of her admission she had no symptoms except a little dyspnea on exertion. Her color was good and she was well nourished. She had been blind in her left eye presumedly from birth, as had been her father, paternal grandfather, and a paternal aunt. The chest was symmetrical but the left side lagged during inspiration. There was flatness to percussion and absent breath sounds over the lower half of the left thorax. The percussion note toward the apex was hyperresonant. There were no râles. There was an area of dullness over the right thorax anteriorly and inferiorly extending out to the midclavicular line. The physical findings elsewhere and on the left side were normal. The heart sounds were regular and heard best to the right of the sternum.

Roentgenogram showed a dense shadow with well-defined, rounded upper border over the lower half of the left thorax. In this shadow were a few areas of increased density suggestive of calcification. The right border of the heart shadow was in the right midclavicular line.

The urine showed normal findings. The blood hemoglobin was 70 per cent, erythrocytes 3,350,000, leucocytes 12,100.

The differential diagnosis included an encapsulated pleural effusion, hydatid cyst and dermoid or other benign tumor. Because of the history of a pleurisy an encapsulated effusion was considered the most likely diagnosis.

On September 19 at exploratory aspiration in the sixth interspace posterior axillary line, 330 c.c. of dark brown turbid fluid was obtained. Microscopic examination of this fluid showed cholesterin crystals, degenerating cells and a few pneumococci. No hooklets could be found.

On September 20, 630 c.c. of a similar fluid was aspirated. Roentgenogram then showed a reduction in the size of the mass and the right heart shadow was 2 cm. further to the left.

A preoperative diagnosis was made of probable dermoid cyst and an exploratory thoracotomy was advised.

On October 18, 1926, operation was performed under local and ethylene anesthesia. A seventh intercostal incision was made with resection of 10 cm. segment of the seventh rib. When the pleura was incised there was a gush of several hundred c.c. of brownish purulent fluid from the pleural cavity. A rib spreader afforded ample exposure. When the remaining fluid had been sponged out an enormous globular greyish yellow tumor came into view. It was about 30 cm. in diameter lying in the lower anterior portion of the pleural cavity in close contact with the mediastinum and extending out to the midaxillary line. The lung was compressed and lay posteriorly. Because of its size and extent and firm adhesions to the pericardium and diaphragm the tumor was incised to reduce its size for better exposure of the adherent part. Several hundred c.c. of brownish, thick, gummy fluid containing much sebaceous material was evacuated. The cyst was then freed from the adhesions to the diaphragm bluntly but the adhesions to the pericardium required sharp dissection. During the progress of this painstaking dissection the patient's pulse became rapid and weak. The mobilized part of the cyst was then excised. The part adherent to the pericardium was left for a later operation and the wound closed without drainage.

The patient's condition improved promptly following administration of stimulants. Roentgenogram four days later showed a large pyopneumothorax and she began to have fever up to 103° F. Because of the pneumococcic infection which apparently had lighted up consequent to operation Dakin's solution irrigation of the cavity was instituted by the closed method. Reexpansion of the lung was slow and ceased when the cavity measured about 100 c.c.

January 12, 1927, the second stage operation was done under gas and local anesthesia. The incision was made in the scar of the former operation. The walls of the empyema cavity presented a clean healthy appearance. The remaining portion of the cyst was about 6 cm. in diameter. The irregular nodular surface was greyish yellow and shiny and showed no granulations. It was very adherent to the pericardium and was removed by sharp dissection. The pericardial wall was cut through in one area but it appeared adherent to the heart muscle so no attempt was made to suture the opening. The wound was closed and a tube inserted for further Dakin's solution irrigation.

The patient stood the operation well and her immediate convalescence was entirely satisfactory. The cyst removed at the first operation measured about 25 cm. in diameter and its walls were from 2 to 5 mm. in thickness. The outer wall was greyish yellow in color and fairly smooth except in the portion which had been adherent to the diaphragm which was rough and covered with fibrous tags. The inner surface was rough and in places nodular and covered with sebaceous material. No hair was seen. There were several areas of dense calcification.

Microscopic examination: The tissue consisted of a mass of unidentifiable, much thickened fibrous tissue containing islands of cartilage and in places the inner surface was lined with skin and hair. The brown fluid from the cyst contained cholesterin crystals. Microscopic examination showed stratified squamous epithelium with hair follicles, subcutaneous tissue, sweat glands and sebaceous glands and some nonstriated muscle tissue. Pathologic diagnosis: dermoid cyst.

Further expansion of the lung did not occur. A two stage thoracoplasty with resection of several ribs was necessary for the obliteration of the cavity. The patient was discharged with the wound almost healed April 16. On June 10, 1927, she reported for examination and at that time the wound had been healed for some weeks and she was entirely symptom-free and in good health. Two years later she was reported to have married and to be entirely well.

CASE 3.—R. W., a boy of eleven years, was first admitted to St. Luke's Hospital June 29, 1929, because of a draining "empyema" sinus present for 6 years. Up to the onset of the present illness he had always been well except for measles and chickenpox.

Six years before, at the age of five years, he had pain in his left chest with some fever. It was at first thought to be a "cold" but after a time the attending physician did an exploratory aspiration and obtained straw-colored fluid. After 3 weeks in bed he gradually recovered and was well until 6 months later when he again had fever and lost weight and strength. A rib resection was then done for drainage of empyema and pus was evacuated. He remained very ill for some time with periodic high fever then gradually improved. During the last two years before admission he had been quite well but a draining sinus had persisted since the operation.

On examination he appeared in fairly good health though quite thin. The left side of his thorax was smaller than the right and the left shoulder was lower than the right. There was a definite lag and deficient expansion of the left side during inspiration. The left chest was dull to percussion anteriorly from the clavicle to the seventh rib and laterally to the posterior axillary line. The breath sounds and vocal fremitus were absent in this area. Posteriorly on the left there was hyperresonance and normal auscultatory findings. There was a linear scar and a draining sinus in the posterior axillary line in the sixth interspace discharging grey-green pus. The physical findings in the right chest and elsewhere were essentially normal.

The urine showed normal findings. The blood hemoglobin was 85 per cent, erythrocytes 4,230,000, leucocytes 11,850.

The chest roentgenogram showed a large circumscribed area of increased density having the appearance of fluid over the left lung field from the second rib to the fifth rib anteriorly.

The diagnosis was chronic empyema with inadequate drainage.

He was operated upon July 5, under local and ethylene anesthesia. Seven cm. segments of the fifth, sixth and seventh ribs were resected through a midaxillary incision. The sixth and seventh were fused together with a hole between them 1.5 cm. in diameter through which the drainage tube had passed. On aspiration only a small amount of pus was obtained. The thickened parietal pleura was then incised and the cavity palpated. It was found to be very shallow and finger impinged on a very firm, rounded mass which had the characteristic feel of a tumor. A dermoid cyst was suspected but because of the presence of pyogenic infection an attempt to explore further at that time seemed unwise. A segment of the tumor wall was excised for biopsy and a drainage tube placed into the cavity for Dakin's solution irrigation. At the close of operation his pulse was 132; the blood pressure was 120 systolic, 80 diastolic.

Postoperatively he had fever for a few days up to 103° F., but which gradually subsided and his condition otherwise was satisfactory.

Microscopic examination of the excised segment of the tumor showed chronic inflammatory tissue.

The patient was taken home to return for extirpation of the tumor after the empyema infection had subsided.

During the next five months the opening into the empyema cavity was enlarged by resecting regenerating segments of ribs previously resected and segments of the second and third ribs were also resected in the region of the axilla for better exposure of the tumor. During these procedures the tumor was separated from its adhesions in its deeper portion and packs were inserted. He always reacted sharply to these manipulations, the temperature often reaching 105°. His blood hemoglobin on January 10 was 46 per cent. He was transfused following which it rose to 70 per cent.

On February 10 under ethylene oxygen anesthesia, the tumor was dissected free from its adhesions to the pericardium. A thick pedicle attached to the anterior mediastinum at the level of the second interspace was clamped and cut, the mediastinal portion ligated, and the tumor was removed. The cavity was lightly packed with vaseline gauze. He had a sharp febrile reaction, the temperature reaching 105°. He then improved gradually but had an exacerbation of fever and malaise two weeks later, incident to a very severe laryngitis and rhinitis lasting two weeks. His further convalescence was uninterrupted and he was discharged home in good condition with an open granulating wound on March 28.

Pathologic report by Dr. Hirsch follows: "This ovoid mass with a fibrous capsule weighs 150.5 grams. Its dimensions are 8 cm. by 6.5 cm. by 6 cm. On one side it is flattened. The flattened side has two irregular openings and channels that extend to a depth of 2 cm. to 2.5 cm. and are irregular in outline, both 1.5 cm. by 1 cm. When the tissue is bisected from the flat side to the rounded side there is close under the rounded side a cyst with smooth lining 2.5 cm. in its greatest dimension filled with a viscid mucin. Toward one end away from the cyst are coarse plates of hyaline cartilage that comprise about one-fourth of this part which is 3.5 cm. in diameter. Such cartilage surfaces made by cutting are up to 1.6 cm. by 0.5 cm. One of them contains gritty cancellous bone substance. These cartilage plates are interspersed with yellow substance like fat and also pink tissue. Toward the opposite pole there is fibrous and fat tissue with some interspersed cartilaginous substance."

Histology: "The histological preparations of the decalcified tissue include large masses of cartilage in a fibrous and fat tissue stroma. There are acini of mucous secreting glands and the cyst linings are transitional mucosa like that of the lining of the trachea and main bronchi. In the stroma beneath this mucosa are aggregates of mucous gland acini. There are also some bundles resembling smooth muscle fibers."

The patient returned for examination three months later at which time the wound was entirely healed. He had gained 21 pounds and was in good condition. He has since been entirely well and has participated freely in football and other school games.

CASE 4.—A male laborer twenty-eight years of age first presented himself for examination at The Mayo Clinic, December, 1916, because of cough with purulent sputum and pain in the left chest. In 1913 he had had "pneumonia." The pain began then and persisted. One year later he suddenly began to cough up yellowish "cheesy" material. After some time the sputum became purulent and foul and has persisted so since.

Examination showed physical and roentgenologic findings consistent with pulmonary abscess of the left lower lobe. The fingers and toes were markedly clubbed. The urine showed normal findings. The blood hemoglobin was 58 per cent, leucocyte count 15,600. The sputum was negative for tubercle bacilli.

He was advised to have some bleeding hemorrhoids removed and to have the abscess drained after treatment for his anemia and weight loss.

Three months after his return home a fluctuating swelling appeared intermittently under the left nipple. Pressing on the tumor would produce cough and evacuation of pus and the tumor would then disappear. After another six months the swelling ruptured and drained pus and this drainage persisted. In March, 1918, the drainage opening was enlarged and in September, 1919, a rib resection was done for more adequate drainage. The examining finger showed a tubular cavity about 6 cm. in diameter extending toward the hilus of the lung.

In October, 1921, he returned, still raising 100 c.c. or more of foul, purulent sputum per day. He showed a very marked osteoartbropathy of fingers and toes. The physical and roentgenologic findings were characteristic of abscess in the region of the second and third rib on the left near the sternum. The blood hemoglobin was 68 per cent, leucocyte count, 10,000. No tubercle bacilli were found in the sputum. Diagnosis was lung abscess.

Operation was performed on January 24, 1922, under local anesthesia when 8 cm. segments of the third and fourth ribs were resected close to the sternum. The pleura was found to be adherent. Aspiration in the third interspace yielded a little pus. With a cautery an opening was made along the needle sufficiently large to insert a finger. About 30 c.c. of pus was evacuated from a deep cavity about 6 cm. in diameter. On sponging out the pus a wisp of hair was brought out revealing the presence of a secondarily infected dermoid cyst with bronchial fistula. The cautery drainage tract was through the anterior margin of the lung partly overlying the cyst.

The cyst cavity was partly filled with a rounded oblong nodular tumor about 2 cm. in length. Long dark hair protruded from this tumor. Because of the acute infection excision of the dermoid was deferred. The cavity was drained through the open wound.

On February 2 under local anesthesia the incision was enlarged medially to the sternal margin and then downward at right angles. The cyst was separated from the lung by blunt dissection but at the pericardium it was densely adherent over a large area. Attempts to separate it here caused considerable bleeding. The cyst was then resected around this adherent area which was about 6 cm. in diameter. This adherent portion of the cyst wall was nodular and projected perhaps 10 to 12 mm., and presented a shiny surface. It was pared away with the scalpel as deeply as seemed safe without opening the pericardial cavity. At the upper inner part of the bed of the cyst was a bronchial fistula about 7 mm. in diameter. The draining sinus in the chest wall communicated with the cavity from below.

The cyst was about 6 to 8 cm. in its longest diameter. It contained a clump of hair. The inner surface was covered partly by skin containing a few hairs here and there. There were several nodular projections on the inner surface perhaps 10 to 12 mm. in diameter located chiefly near the pericardial portion. The outside wall was greyish white and fairly soft. The wound was packed with gauze.

Microscopic examination showed squamous epithelium with hair follicles, and oil and sweat glands.

Two weeks later the bronchial fistula was cauterized and two pearly grey areas in the pericardium were excised.

The patient had gained 15 pounds when he was discharged on April 14 and the wound was healing rapidly. There was almost no cough or sputum or other symptoms. He later reported that the wound was entirely healed and he was quite well and remained so during several years.

CASE 5.—F. M. H., female fifty-four years of age, presented herself at The Mayo Clinic in February, 1919, with a history of a goiter which she had had for 30 years and with recent nervousness, palpitation, tachycardia and loss of 20 pounds of weight. She had a total arrhythmia, the heart was enlarged and there was a blowing systolic murmur at the apex which was transmitted. The pulse averaged about 140. The blood pressure was 172 systolic, 104 diastolic. The electrocardiogram showed auricular fibrillation and ventricular extrasystole. There was flatness and absent breath sounds over most of the right chest. The hemoglobin was 75 per cent, leucocyte count 30,000.

The roentgenogram showed a shadow in the right lung field up to the second rib. The clinical diagnosis was thyrotoxic adenoma, myocardial degeneration, auricular fibrillation and pleural effusion.

After two weeks of treatment with digitalis and other medical care an exploratory thoracentesis was performed which yielded canary yellow fluid, 750 c.c. of which was aspirated and which showed pneumococcus on culture. Two weeks later closed drainage was established and 750 c.c. of the same kind of canary yellow fluid was aspirated. Dakin's solution irrigation then was instituted. The cavity measured about 800 c.c.

During the following weeks the symptoms of hyperthyroidism became more pronounced. There had been a loss of weight of 27 pounds. The metabolic rate was 51 plus. A left superior thyroid artery ligation was then performed. During the following three months her condition showed considerable fluctuation but on the whole there was some improvement though at no time was her condition sufficiently good to warrant a thyroidectomy. The empyema cavity was reduced to less than 100 c.c. capacity but continued infected. On July 26, 1700 mg. hours of radium, and on August 1, 2400 mg. hours of radium were used over the thyroid gland. During the next days she developed marked fibrillation and persistent vomiting and died with terminal findings of bronchopneumonia.

The necropsy showed a calcarious adenoma of the thyroid, pyothorax and dermoid tumor attached to the central tendon of the diaphragm and there were two hair balls, each about 4 cm. in longest diameter, in the pleural cavity.

CASE 6.—D. C., a girl seven years of age, was admitted to the Augustana Hospital July 19, 1927, because of a draining sinus just to the left of the sternum in the second interspace.

Except for measles and whooping cough her past history was not remarkable.

At the age of one and one-half years she had "acute tonsillitis" for about 10 days and then began to vomit, had continued fever and was "restless" for some weeks. A year later during an attack of high fever an empyema was drained by resecting the second left costal cartilage and the distal end of the second rib. The drainage opening had persisted during the 5½ years that had since elapsed.

She was fairly well nourished, weighing 48¾ pounds. The physical examination showed normal findings except for the thorax. There was a sinus about 2 mm. in diameter in the second left interspace about 1 cm. from the sternal margin discharging a thick, greenish pus. On percussion the left chest was flat from the sternal margin to about the anterior axillary line extending from the cardiac area upward to the first interspace. Posteriorly in the upper paravertebral area the percussion note was impaired. Laterally in the axillary line the note was tympanitic. Over the area of flatness anteriorly the breath sounds were absent. The apex beat was in the

fifth interspace. The temperature was 99.3, pulse rate 132, respiration 24. The blood pressure was 90 systolic and 72 diastolic.

Roentgenogram showed the heart displaced somewhat to the left and there was a dense shadow in the upper left lung field with sharply demarcated rounded border, well seen in the anterior, posterior, and lateral views. It did not pulsate and seemed continuous with the aortic shadow. Films taken after injection of lipiodol into the sinus showed the dense shadow of the oil in an irregular space in the second interspace anteriorly in the outer portion of a uniform lighter shadow and extends into the mediastinum. "The findings were consistent with a diagnosis of a cyst or encapsulated empyema." The lateral lung fields were not remarkable. The preoperative diagnosis was mediastinal empyema.

August 1, 1927, operation was performed under local anesthesia. Incision was made in the second interspace and the second rib and cartilage were resected. The sinus was dilated sufficiently to admit the examining finger which entered into an irregular cavity about 4 cm. deep and about 3 cm. in diameter with nodular walls extending downward into the mediastinum and outward and containing thick pus. A small segment of tissue was excised from the wall for biopsy and the cavity was packed with iodoform gauze. Microscopic examination of the tissue removed showed squamous epithelium.

The operation was followed by a sharp reaction—the temperature reaching 103.6° and the pulse 132, but both temperature and pulse became normal by the end of a week after operation. She was discharged in good condition on the eighth day after operation.

The patient came regularly to the dispensary for dressings. There was a rather profuse discharge of a peculiar sour smelling, greyish white pus, the unusual character of which was frequently remarked upon. Her general condition remained fairly good.

On November 14, 1927, she was readmitted for further operation because of the inefficient drainage through the narrowing sinus.

November 14, operation was performed under local anesthesia. The old scar was resected and the sinus was enlarged, as much as possible of the thick nodular greyish shiny abscess wall was cut away. The cavity was then swabbed out with Zenker's solution and packed with gauze.

The postoperative reaction was very slight, temperature reading 99.8° and pulse 126. She was discharged a few days later in good condition.

She was seen from time to time in the dispensary. Her general condition was good but the discharge from the sinus persisted and was of the same peculiar sour smell, suggestive of gastric contents and of the same greasy character as before. The cavity was cauterized from time to time with silver nitrate.

About a year later she became suddenly very ill and was taken to a hospital at a distance where she was seen in consultation. At this time the findings were those of an acute empyema and a large amount of pus was aspirated in the posterior axillary line and a tube finally inserted for closed drainage. She died on the sixth day of this illness with symptoms of pneumonia. A necropsy was not allowed.

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SURGICAL TREATMENT IN ELEVEN CASES OF MEDIASTINAL AND INTRATHORACIC TERATOMAS*†

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THE purpose of this paper is to summarize the clinical symptoms, methods of diagnosis, surgical treatment, and results in eleven cases of mediastinal and intrathoracic teratomas in which I have operated in the last five years. Six of these cases have been reported previously and only reference to the published articles concerning them will be given here. The remaining five cases will be reported.

The etiology of teratoid tumors has been the subject of much investigation and speculation. Many hypotheses have been advanced to explain the origin of these growths, but the question of derivation of the tissues of which they are composed has never been definitely determined. I shall not consider in detail the various hypotheses but will mention only those that appear most plausible as they influence the terminology used to designate the different types of tumors. The earlier hypotheses were based on the conception that these growths were composed of tegmental structures only, and that they are the result of inclusion of an invaginated portion of the ectoderm at the time of closure of the primitive wall of the thorax.

The term dermoid tumors was given to these growths on the basis of this early view, and most of the earlier cases in the literature are reported as such. In many such cases the term is a misnomer as the lesions are of more complex structure. When serial sections of the tumor began to be made, their histologic structure became clearer. It was found that many contained tissue derived from the mesoderm and entoderm, and it was impossible to explain the presence of these tissues on a basis of invagination of ectoderm. The hypotheses of origin from the thymic gland, the thyroid gland, the branchial clefts, and the bronchi were then advanced but these failed to explain the presence of many tissues. Because of the presence in many growths of tissue derivations from all of the blastodermal layers, it was thought that fetus in fetu might explain the autogenesis of the majority of these conditions. There are many examples of growths containing fetal tissue, but it is extremely rare for these growths to become so highly developed to be recognized as a fetus. Certain embryologists claim that the growths are never enclosed within the cavity of the body, and that they should exhibit traces of vertebral

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segments to prove the presence of metamere structure before they can be considered as bigeminal parasites.

Since the origin of these tumors has not been definitely proved, the terminology should depend on the histologic study of the tissues contained in the growth. Inasmuch as many of the tumors contain tissues derived from all three germinal layers, ectoderm, mesoderm and entoderm, it is best to group them all under the general term teratoma and qualify them according to the type of tissue which predominates in the growth.

In this series of eleven cases of teratoma, four were of the dermoid type, although in only one of these four were the structures derived from the ectoderm alone. In the other three cases the structures were mainly derived from the ectoderm and were at first thought to be true dermoid cysts, but later extensive serial sections through the tissue revealed structures derived from all three of the germinal layers although few structures were derived from the mesoderm and entoderm as compared with those derived from the ectoderm. In five cases the tissue elements were derived from all three of the germinal layers; three of these growths may be considered of the bronchogenic type; one of indefinite origin may be considered diaphragmatic, and the structures of one had attained such a high degree of organoid structure that it was designated as a fetal parasite. The remaining two growths were squamous-cell epithelioma, graded 4. This I believe to be a malignant change of a teratoma of the dermoid type.

In ten of the cases the tumor originated in the mediastinum; in five of these the tumor projected into the left thoracic cavity, and in four into the right thoracic cavity. In one case the tumor was confined to the anterior and superior mediastinum and appeared in the neck. In the remaining case the tumor apparently originated in the right side of the diaphragm and may have originated from cell occlusion with improper fusion of the septum transversum and pleuroperitoneal membrane at the time of closure of the diaphragm. In ten of the cases the tumors were cystic; in the remaining case it was solid, this being the one designated as a fetal parasite.

The contents of the cysts were hair and sebaceous material in four cases which were of the dermoid type; in the remaining cases clear fluid with cholesteral crystals was present. In the malignant cases there was bloody fluid. The lining of the cysts consisted of columnar epithelium in three cases; squamous epithelium in four cases, and degenerated fibrous tissue with areas of epithelium in the two malignant cases and in the one case which originated in the diaphragm. A great variety of structures were found in the walls of these cystic tumors in making serial sections. The most common structures were various types of glands; mucous glands were found in four cases; salivary glands in

two; sebaceous glands in six; sweat glands in five; cartilage in five; bone in four; teeth in one case; muscle tissue in three cases; connective and fibrous tissue in six; lipoid tissue in three; nerve tissue in two; thymic tissue in one case, and pancreas in one.

The average age of the patients in this series was thirty-three years; the youngest was seventeen and the oldest fifty-nine. In nine cases the tumor was benign and in two it had undergone malignant change. The ages of the patients in these two cases were forty-nine and fifty-nine years, respectively, the oldest patients in the series. The average age in the benign cases was twenty-nine years.

Seven of the patients were women and four were men. In the two malignant cases one patient was a man and the other a woman. The average duration of symptoms was two and a half years. Pain was the chief complaint noted in seven of the eleven cases; cough was the chief complaint in two cases and in both of these the expectoration contained blood and hair at intervals. In the remaining two cases the patients had been operated on previously elsewhere and had draining wounds. In one of these the tumor had been partially removed by multiple operations and in the other exploration had been done.

In reviewing the symptoms in these cases it was found that dyspnea was the most common symptom usually noted on exertion; it was present in nine cases and was usually associated with pain. The degree of dyspnea depended on the size of the tumor and its site. It was most marked in cases in which a large tumor projected into the thoracic cavity and caused partial collapse of the lung. Pain was the chief complaint and was dependent more on the site of the growth than on its size. It is also the most important symptom in the clinical differentiation of benign and malignant growths. In cases of malignancy the pain was at first intermittent, then progressively more severe until it was more or less constant. The pain was most severe at night and required sedatives for relief; in both cases it radiated down the arm. In the benign cases the pain was much milder, usually localized in the substernal region, occasionally radiating along the wall of the thorax, and it was usually believed to be due to pleurisy. The pain often subsided with rest and conservative treatment.

Cough was the chief complaint in two cases and was part of the complaint in four other cases. In the two cases the attacks of coughing occurred chiefly at night and were associated with the expectoration of thick, tenacious mucoid material and hair, and occasionally by moderate hemorrhage from the lung. This is pathognomonic of the presence of a teratoid tumor of the dermoid type which has ruptured into the lung and produced bronchial fistula, the hemorrhage resulting from secondary abscess in the lung. In the four cases the cough was of a dry type in

two and associated with mucoid expectoration in two. It is of interest to note that in one of the malignant cases there was a dry, nonproductive cough, and in the other there was no cough or expectoration.

Bulging of the wall of the thorax was noted in three cases. In one of the malignant cases it was first noted thirty years previously. In the two benign cases it had been noted five and three years previously.

The most common features in these cases were the intermittent character of the subjective symptoms, their gradual progression and their association with acute respiratory infections, which accounts for the frequency with which a diagnosis of pleurisy, pleural effusion, pneumonia and bronchiectasis was made clinically in eight of these cases. In a few cases the diagnosis of a teratoid tumor can be made on the clinical symptoms and the physical condition, but in most cases other methods must be resorted to in order to establish a correct diagnosis. The most important of these is a thorough roentgenographic examination of patients who present suggestive symptoms.

The roentgenologic examination should consist of films taken in the anteroposterior, true lateral and oblique positions; stereoscopic films and fluoroscopic examination of the thorax are of great value in determining the true position of the growth and its relation to the surrounding normal structures of the thorax. The value of the roentgenologic studies is often greatly enhanced by the introduction of artificial pneumothorax before the examination, but artificial pneumothorax is often impossible in these cases because of adhesions between the visceral and parietal pleura due to an inflammatory reaction in the tumor. Injecting the bronchial tree with lipiodal, and bronchoscopic examination are often of value in distinguishing between an intrapulmonary and an extrapulmonary lesion.

SURGICAL TREATMENT

All teratoid tumors should be removed surgically regardless of whether the growth is producing symptoms. If these tumors are allowed to remain, there is danger that the growth will undergo malignant change. If the growth remains benign the course is usually progressive and will ultimately cause serious complications and chronic invalidism either from pressure on the surrounding vital organs, particularly the heart and lung, or it may cause inflammatory changes. Not uncommonly infection develops and the growths rupture into the lung from pressure and are secondarily infected, producing bronchial fistula or secondary abscess which often produces severe hemorrhage from the lungs, and may result fatally. The growths should be removed before these complications have occurred, but unfortunately many patients do not present themselves until serious symptom or complication has developed.

The methods of approach and types of operative procedure depend, to some extent, on the site of the tumor and the complications that have

occurred. Each case must be considered individually, depending on the indications presented. A few general principles apply to all cases. The most important is early operation and complete removal of the tumor; this may be accomplished in multiple stages but I prefer to remove the growth in one stage if possible as the second stage may be more hazardous and difficult than the first. Incomplete removal of the growth may be followed by more serious trouble, and will usually require subsequent operative procedures.

The method of approach may be through the anterior or posterior wall of the thorax, but I prefer the posterior approach, particularly when the tumor projects into the pleural cavity or is adherent to the lung, because much greater exposure can be obtained and the important structures to which the tumor is adherent, usually the heart, the great vessels and the lung, can be carefully dissected from the growth under direct vision. Any injury to these structures caused by tumor or operative procedure can be detected and repaired immediately, and if infection is encountered in the cyst or lung, drainage can be readily instituted. If the tumor is confined to the anterior or superior mediastinum, I prefer the anterior approach, either splitting the sternum, or resecting the cartilage and turning back the wall of the thorax.

In this series of cases posterior thoracotomy and mediastinotomy was done in seven cases, posterior thoracotomy in one case, posterior thoracotomy and repair of a defect in the diaphragm in one case, and anterior mediastinotomy in two cases in one of which the sternum was split and in the other three cartilages and a portion of the corresponding ribs were resected. The tumor was completely removed in ten cases, all by one-stage operation. In seven of these cases, the growth was removed transpleurally, and in three cases extrapleurally. In three cases it was necessary to cut into the lung to remove the growth and the tissue was repaired by suture. The remaining case was malignant and inoperable.

The method of administering the anesthesia is of great importance because one of the chief dangers associated with removal of these growths is an open pneumothorax. This condition not uncommonly is accompanied by flapping of the mediastinum with serious impairment of respiration and circulation, and it may result in sudden death. This danger is practically eliminated by the use of intratracheal anesthesia. The gas is administered with a positive pressure apparatus. Intratracheal gas anesthesia was used in nine cases. In the remaining two cases gas was administered with a closed mask, because the pleural cavity had been walled off by previous operations.

Indications for draining the thoracic cavity are presented in each case. When there is no infection, or no complication in the removal of the tumor, the thoracic cavity should be closed without drainage. If the tumor is infected and the pleural cavity is contaminated, it is

usually best to drain the cavity or the mediastinum. I prefer to drain the pleural cavity by the intercostal closed method. In this series of cases the thoracic cavity was closed in four cases and drained in five. The mediastinum was drained in two cases.

In practically all cases postoperative effusion develops which usually requires repeated aspirations; in some of these cases empyema ultimately develops that requires drainage. Occasionally a mediastinal abscess or osteomyelitis of the ribs occurs.

The convalescence in four cases of this series was uncomplicated except for moderate pleural effusion requiring one or two aspirations. In six cases pleural effusion developed requiring repeated aspirations; in three cases empyema developed requiring drainage with rib resection; in one case mediastinal abscess developed requiring rib resection for drainage, and in one case osteomyelitis of the ribs developed necessitating the partial removal of three ribs.

Postoperative care is of the utmost importance. Particular care should be taken to maintain the blood pressure and to relieve any respiratory difficulty. It is usually advisable to give some form of intravenous medication either during the operation or immediately afterward. If there has been much loss of blood, transfusion of blood should be given; if not, acacia is satisfactory. Respiratory difficulty is the most serious immediate complication and is best relieved by placing the patient in an oxygen cabinet. This is often a life-saving procedure, as sufficient oxygen can be obtained to tide the patient over the most critical postoperative period of respiratory embarrassment. In six cases of the series a transfusion of blood was given on the operating table and in seven cases the patients were placed in the oxygen cabinet immediately on leaving the operating room. The hospitalization period varied from eighteen days to five and a half months.

Ten patients recovered from the operation. There was one operative death on the seventh day from cerebral embolism. Nine patients are living with complete relief of symptoms. One patient died subsequent to operation for a malignant lesion.

REPORT OF CASES

CASE 1.—A man, aged twenty-seven years, came to The Mayo Clinic October 12, 1931, because of a tumor of the thorax. Five years previous to admission, his tailor called his attention to a bulging in the anterior right wall of the thorax. He was in good health and had no symptoms. Two years previous to admission, he first noted a mild cough. He had had several severe coughing spells at night particularly when lying on his back. One year before admission, he was awakened during the night by a violent attack of coughing, associated with dyspnea. Each breath brought on a spell of unproductive coughing. Following this attack he continued to have spells of coughing and in a few days expectorated a moderate amount of thick and tenacious sputum. One month later he first noted a few hairs varying from 1 to 2.5 cm. in length in the sputum. He continued to cough and raise sputum

which was usually clear and frothy, but occasionally it contained dark blood and hair. After exercising he occasionally raised sputum which was very irritative to the throat. He continued to work but had to cease all violent exercise. At irregular intervals he coughed violently and raised hair and thick tenacious sputum, which almost caused strangulation. He continued to work until five months before admission. In the last five months the cough had improved and he had gained 5 pounds. He had no other complaints except frequent frontal headaches.

The patient was well developed, six feet tall and weighed 175 pounds. The systolic blood pressure was 150 and the diastolic 90 in millimeters of mercury. The pulse rate was 80. The temperature was 99.2° F. There was marked prominence of the right side of the thorax anteriorly and dullness over the entire right side both anteriorly and posteriorly. Loud tubular breathing was noted to the right of the sternum in the third interspace. There was delayed expansion of the entire right side of the thorax, and the heart was displaced to the left. There were enlarged veins in the neck, and cyanosis on stooping. Roentgen examinations included anteroposterior, stereoscopic, lateral and fluoroscopic views, and disclosed a large rounded tumor apparently originating in the anterior right mediastinum and occupying approximately three-fourths of the right hemothorax causing almost complete compression of the right lung and displacing the heart to the left. The tumor appeared to contain plaques of calcium in the margins and bone in the central portion. Urinalysis gave negative results. The concentration of hemoglobin was 58 per cent (Dare); erythrocytes numbered 3,060,000 and leucocytes 8,600 in each cubic millimeter of blood. The Wassermann reaction of the blood gave negative results.

A clinical diagnosis was made of right anterior mediastinal and intrathoracic dermoid cyst causing almost complete compression of the right lung and communicating with a bronchus. Operation was advised, and preliminary artificial pneumothorax was done October 17, 1931, and again October 21, 1931. Artificial pneumothorax was unsatisfactory, as only approximately 300 c.c. of air could be introduced into the thoracic cavity. This was due to the large tumor which had compressed the lung against the inner wall of the thorax, and many adhesions had formed between the visceral and parietal pleura.

October 24, 1931, the tumor was completely removed by a one-stage transpleural operation. Right posterior mediastinotomy was done by removing 20 cm. of the seventh rib, and the pleural cavity was entered through the inner layer of the periosteum of this rib. The fifth and sixth ribs were cut to increase exposure. The tumor was found to be a huge dermoid cyst originating in the right anterior mediastinum and projecting into and causing almost complete collapse of the right lung. It had completely collapsed the middle and lower lobes and infiltrated into the parenchyma of the middle lobe, producing a bronchial fistula. The lower portion of the tumor was adherent to the diaphragm at the level of the eighth rib and extended up to the fifth rib, practically filling three-fourths of the right thoracic cavity. The tumor was firmly adherent to the lung and in several places had ruptured into its tissues. The outer wall contained large amounts of cartilage and it was impossible to find any line of cleavage between the lung and the tumor, so that the tumor had to be removed from the lung by knife dissection. It was also quite adherent to the pericardium just below the root of the great vessels, and the upper part of the tumor had forced its way deep into the central portion of the upper lobe of the right lung. The tumor was 24 cm. in diameter and contained more than 1,500 c.c. of thick sebaceous material and hair. Because of the infiltration of the tumor into the lung, it was ruptured during its removal, and the wall of the tumor

had to be cut from the lung. There was considerable oozing from areas from which the tumor was removed, particularly from the thoracic wall where the pressure of the tumor had caused marked bulging anteriorly. It was necessary to suture several areas where the tumor was dissected from the parenchyma of the lung. The anterior median portion of the cavity which remained after the tumor had been removed, was packed with a strip of gauze and the thoracic wall was reconstructed by resuturing the ribs and closing the posterior portion of the incision completely, bringing the drains out of the anterior angle of the wound.

Pathologic examination of the tumor disclosed a dermoid cyst measuring 24 by 18 by 10 cm. and weighing 918 gm. It contained hair, squamous epithelium, sweat glands, sebaceous glands, two teeth, neuroglia, gland epithelium, bone, cartilage and smooth muscle.

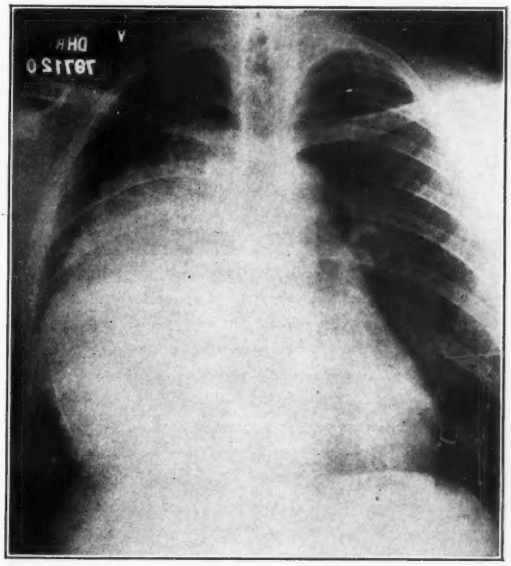

Fig. 1.—Anteroposterior view of large mediastinal teratoma (dermoid type) originating in the anterior mediastinum causing almost complete collapse of the right lung.

The patient was given acacia during the operation and a transfusion of blood immediately after the operation. Considerable shock followed. The pulse was 150 beats; the blood pressure was 70 systolic and 40 diastolic in millimeters of mercury. He was taken from the operating room directly to the oxygen chamber and about six hours later was given a second transfusion of blood. The pulse rate dropped to 120 and systolic blood pressure increased to 80. Twenty-four hours after the operation the pulse was 120 and the systolic blood pressure was 110. Conditions remained about the same until the third day when moderate dyspnea developed, and it was necessary to aspirate the right thoracic cavity. About 700 c.c. of bloody fluid was removed. The patient's condition began to show gradual improvement. Respirations were from 21 to 26, the pulse rate from 112 to 124, and the temperature varied from 90° to 100.6° F. Seven days after operation the oxygen concentra-

tion was gradually lessened and an attempt was made to remove him from the oxygen chamber but he became short of breath and cyanotic and was replaced.

The abscess cavity gradually obliterated with expansion of the lung. The wound was completely healed in five weeks. The patient was dismissed five and a half

Fig. 2.—Lateral view of tumor shown in Fig. 1.

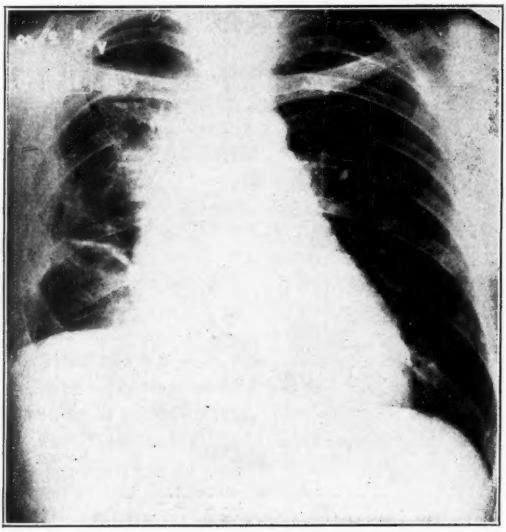

Fig. 3.—Seven months after complete removal of tumor. Right lung about two-thirds expanded with intralobar and pleural thickening. Pulmonary fields are negative.

months after operation. Roentgenograms showed the lung to be expanded. There was marked thickening of the pleura of the lateral thoracic wall, but the lung fields were normal. He had gained 20 pounds and was free of symptoms except for a small sinus in the anterior thoracic wall (Figs. 1, 2 and 3).

This case is of interest because of the huge size of the tumor which had evidently been present for a long time as the bulging of the ribs had been noted five years previously, and also because of the relatively few symptoms, there being none until two years previously. It is rather unusual for a teratoma to become so large without causing considerable pain. It is also of interest that this is one of the two cases in the series in which the chief complaint was cough with expectoration of hair. Operative procedures were extensive. It was impossible to consider a two-stage operation because of infiltration of the tumor into the lung, and there was no way in which the procedure could be divided into stages without increasing the risk. The blood pressure and the circulation were supported during operation by intravenous medication. The chief risk was the respiratory difficulty which was encountered postoperatively, and is one of the best examples of the necessity of placing these patients in the oxygen cabinet. The respiratory difficulty in this case lasted longer than following any intrathoracic operation I have performed. Since the patient was in a cabinet it was possible partially to drain the postoperative mediastinal abscess without interference with the oxygen supply. The great risk which is entailed by the surgical removal of tumors of this size and the prolonged duration of the convalescence necessitated by such severe complications, is one of the greatest arguments in favor of early removal before such complications have developed.

CASE 2.—A woman, aged forty-one years, came to the clinic May 27, 1932, because of cough and expectoration for five years. Generalized weakness accompanied the onset in 1926. In June, 1928, she had experienced headaches, chills, fever, increased coughing, and sharp pain in the right arm pit with considerable expectoration on the sixth day. She also had pain in the right side of the thorax, and dyspnea and fever. A diagnosis of pneumonia was made. On the twelfth day fluid was removed from the thorax and a few days later, pus. A diagnosis of empyema was made and on the eighteenth day a portion of the ninth rib was removed. Pus and cheesy substance were found. The patient was in the hospital for six weeks. She had had one slight hemorrhage. The drainage tube was removed a month later and the incision healed. The cough and expectoration continued with several attacks of chills and fever. In March, 1929, another slight hemorrhage was noted. The patient gradually improved until the spring of 1931 when she coughed up a few hairs and felt run down in general. In the autumn of 1931, she had what was diagnosed as influenza, and March, 1932, she had had several hemorrhages. One month later she had chills, fever, malaise and cough with expectoration of hair and cheesy material. The condition was then diagnosed as dermoid cyst and she was referred to the clinic.

The patient was tall and asthenic. Motion was decreased on the right side of the thorax and there was dullness and decreased breath sounds and amphoric type of breathing at the right apex. A few scattered râles were heard on the right side. The heart was displaced to the right. The blood pressure in millimeters of mercury was 114 systolic and 70 diastolic. The pulse rate was 100 beats. Urinalysis was

negative. The concentration of hemoglobin was 12.9 gm. in each 100 c.c. of blood; erythrocytes numbered 3,880,000 and leucocytes 16,100 in each cubic millimeter of blood. The flocculation test was negative. Roentgenograms of the thorax revealed a fractured ninth rib on the right in the axillary line, probably the site of the old thoracotomy. Retraction of the upper portion of the right lung was present. The right lung field was diffusely opaque, extending from the level of the third anterior rib to the level of the fifth, and containing an apparent area of cavitation at about the level of the third rib. The lateral view revealed an old pulmonary abscess on the right side with areas of calcification.

A clinical diagnosis was made of right anterior mediastinal teratoma (dermoid type) which had ruptured into the lung, with secondary multilocular bronchiectatic abscesses in the middle lobe of the right lung. A preliminary bronchoscopic exam-

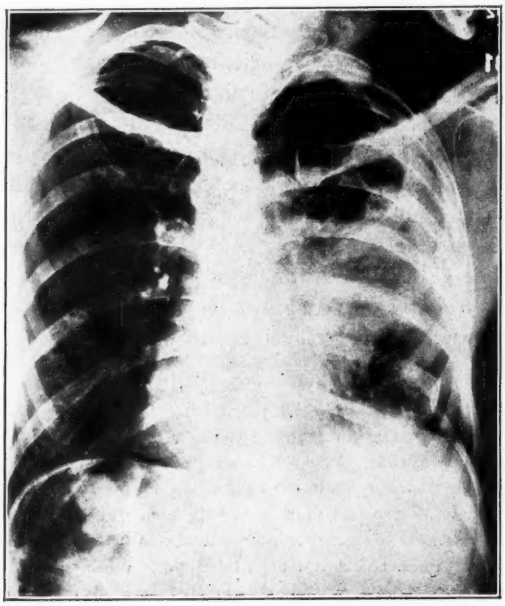

Fig. 4.—Extensive pulmonary suppuration which was secondary to ruptured dermoid tumor. It was impossible to visualize the mediastinal tumor because of inflammatory reaction in the lung.

ination was done June 1, 1932, and a small amount of purulent secretion was found coming from the middle lobe bronchus. The bronchus was partly strictured and it was necessary to use a little force in introducing the aspirating tube into the substance of the injected area. Roentgenograms following this revealed a dermoid cyst of the right lung (Fig. 4).

June 14, 1932, posterior thoracotomy and exploration was done under intratracheal ethylene anesthesia. The thoracic cavity was explored by resecting the posterior segment of the sixth rib. There was marked thickening of the pleura with adhesions to the lung and visceral and parietal pleura so that it was not possible to examine the tumor within the pleural cavity, and the wound was closed. Convalescence following the exploratory operation was uneventful, and the patient was dismissed from hospital on the eleventh day. She returned for further operation

July 6, 1932, at which time anterior mediastinotomy with resection of portions of the second and third ribs and enucleation of the tumor were performed. The multilocular bronchiectatic abscesses were drained. Gas intratracheally and ether were used as an anesthetic. An incision was made just to the right of the midsternal line at the level of the second rib to the level of the fifth rib, then a lateral incision up and toward the shoulder parallel with the second rib and down and out parallel with the fifth rib. The skin, subcutaneous fat, muscle and breast tissue were all reflected back from the thoracic wall. The cartilaginous end of the third rib was then removed. On exploration of the anterior mediastinum, a hard mass was encountered just below the third and second ribs. The anterior third to half of the second rib including the cartilage up to the border of the sternum was resected, and the intervening intercostal muscles and parietal pleura between the second and third ribs were removed. A firm mass was encountered immediately

Fig. 5.—Teratoid tumor of dermoid type removed from anterior mediastinum and containing epidermis, sebaceous glands, sweat glands, mucous glands, hair, fibrous tissue, fatty tissue, smooth muscle and cartilage.

under the thoracic wall which extended down into the anterior mediastinum. The adherent mediastinal tissue was dissected from this mass and a partially preserved capsule to a tumor was found. The median portion was removed readily although it was very adherent to the mediastinal structures, and posteriorly it was adherent to the pericardium and great vessels. The right portion of the tumor had perforated the right lung, apparently the middle lobe, and had formed large multilocular bronchiectatic abscesses, filled with sebaceous material and considerable hair. The entire tumor was filled with hair and many nodular processes covered with skin extending into the center of the mass. There was considerable hemorrhage inside the tumor, particularly from these multilocular bronchiectatic abscesses. The tumor was dissected out of the lung. The abscess pockets were packed with gauze and the wound was left open. Pathologic study of the tissue revealed teratomatous cyst containing epidermis, sebaceous glands, sweat glands, mucous glands, hair, fibrous tissue, fatty tissue, smooth muscle and cartilage.

The patient's condition following the operation was satisfactory. She was dismissed from the hospital July 22, 1932. One month later, a small plastic procedure was done on the wound for better drainage of the pulmonary abscess. September 19, 1932, her general condition was good; she still had a small bronchial fistula (Figs. 5, 6 and 7).

This case demonstrates the variety of serious complications which are occasionally encountered in tumors of this type as well as the difficulty which is often encountered in their removal after these complications have developed. As the patient's early history indicates, she had had

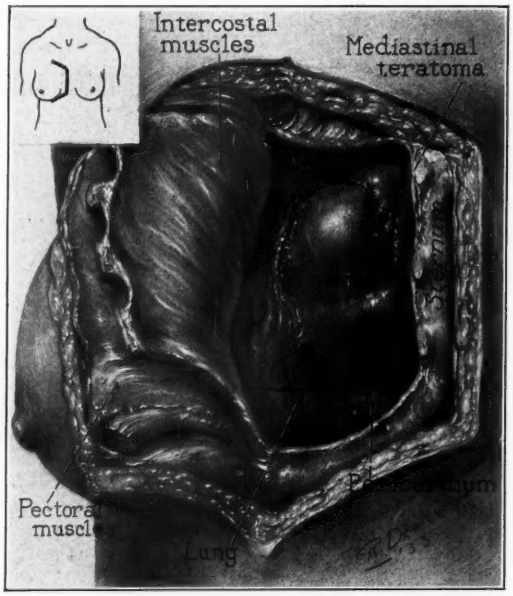

Fig. 6.—Drawing made at time of operation. The anterior approach is made by turning back an osteoplastic flap exposing the dermoid of the anterior mediastinum, which had ruptured into the middle and upper lobes of the right lung. Insert shows site of incision.

repeated attacks of mild inflammatory reaction from the tumor; later, infection had developed in the growth which had ruptured into the lung, and produced a pulmonary abscess. Rupture of the abscess into the pleural cavity produced empyema and drainage was instituted. The drainage relieved the immediate acute condition, but the infection in the tumor as well as in the lung remained and continued to produce symptoms of gradually increasing severity until they endangered life from repeated hemorrhages. The surgical difficulties entailed were those due to the extensive inflammatory condition caused by the tumor throughout the thoracic cavity. The empyema had sealed the visceral and

parietal pleura, making it impossible to approach the tumor posteriorly, and an anterior operation was necessary. This proved to be satisfactory because of the associated multilocular bronchiectatic abscess contained in the lung, for which partial pneumonectomy and drainage was done at the time the tumor was removed. Although the growth had been removed, the patient's symptoms were not entirely relieved because the lung was still considerably diseased and it is questionable whether the drainage and partial removal of the diseased pulmonary tissue will be sufficient wholly to relieve symptoms. This again stresses the importance of early diagnosis and immediate surgical removal of the tumor in such cases, and it demonstrates the frequency with which this condition is con-

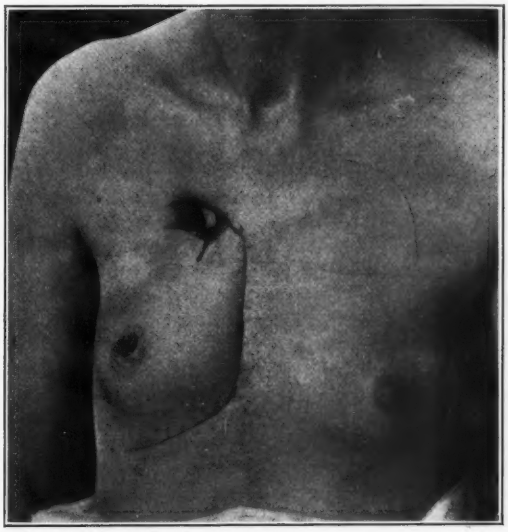

Fig. 7.—Incision of anterior approach. Wound entirely healed except where plastic operation has been made in the upper angle for drainage of multilocular pulmonary abscesses.

sidered an inflammatory lesion of the lung. The correct diagnosis was not established in this case until five years later when the patient expectorated hair during one of her attacks of coughing, which was associated with hemorrhage.

CASE 3.—A man, aged twenty-nine years, came to the clinic January 17, 1931, because of cough, expectoration, and a draining sinus. The trouble had begun thirteen years previously with pain in the left side of the thorax, and a diagnosis of influenza was made. Several months later the pain again developed, accompanied with a feeling of malaise and weakness. A diagnosis of pleurisy with effusion was made. The left thoracic cavity was aspirated and about 1,000 c.c. of "watery fluid" was removed. The patient was not confined to bed, but became gradually worse and a week or two later two ribs were partially resected and re-

moved. Since that time four operative procedures of considerable magnitude had been carried out, but considerable pus-like material and débris had continued to drain. Air coming from the wound had been noted for several years. With decrease of drainage, the cough and expectoration usually increased.

The patient was obese. The blood pressure in millimeters of mercury was 126 systolic and 80 diastolic. The pulse rate was 78 beats. There were several scars in the region of the eighth and ninth ribs posteriorly, and two sinuses, the lower one draining viscid, mucoid material. Breath sounds were absent below the scar and at the base of the lung posteriorly, but present elsewhere. The percussion note was dull around the scar and flat below. There were a few râles in both bases laterally and anteriorly. There was no apparent displacement of the mediastinum. Fingers and toes were clubbed graded 2. Urinalysis was negative. The value for hemoglobin was 16.7 gm. in each 100 c.c. of blood; erythrocytes numbered 4,580,000 and leucocytes 9,400 in each cubic millimeter of blood. The Wassermann reaction of the blood was negative. Bacilli of tuberculosis were not found in the sputum or in smears from the sinus. Roentgen examination of the thorax disclosed pleuritic thickening of the left base and left periphery, and an area of infiltration in the second and third interspaces anteriorly. A clinical diagnosis was made of a recurring chronic left empyema with bronchial fistula.

January 24, 1931, an open operation was done with multiple rib resection, completely unroofing the cavity. Ethylene gas and ether were used to induce anesthesia. The probe was passed into the upper portion of the sinus and entered a definite cavity which held between 60 and 90 c.c. of foul green pus. The upper two-thirds of the cavity was lined on all sides with squamous-cell epithelium. The cavity extended in the posterior vertebral gutter and backward to the mediastinum at the level of the fourth rib. It was necessary partially to resect three ribs besides the four ribs that had been resected, in order to unroof the upper angle of the cavity. The cavity contained a sequestrum of bone. The entire cavity was unroofed as an empyema cavity, with removal of the overlying thickened pleura and intercostal muscles, and the squamous-cell epithelium in the upper portion of the cavity was dissected from the visceral and mediastinal pleurae. There were multiple (six) bronchial fistulas presenting in the cavity. The operation was difficult because of the reformation of bone from previous operations, the enormous amount of scar tissue and firm adhesions of epithelium to the surrounding structures. Pathologic examination of the tumor disclosed a portion of the sac between the bronchi and pleura on the left side, also ribs, soft parts and sequestrum of bone. The sac proved to be a dermoid cyst lined with squamous-cell epithelium; it contained hair, sebaceous glands, sweat glands, erector pili muscles and subcutaneous fat. The soft parts were inflammatory.

The patient's convalescence was uneventful and he was dismissed from observation March 23, 1931, eight weeks after the operation. Several small bronchial fistulas still remained in the upper angle of the cavity, and there was a moderate amount of drainage.

It is difficult to evaluate the early history in this case because of the long interval since the first surgical treatment, but it seems likely that a teratoma of the dermoid type had been present in the anterior mediastinum, causing both pulmonary and pleural infection, and that in the repeated operations, only a portion of the tumor had been removed. The remnants remaining were responsible for continuation of drainage from the wound, a condition which has been considered a

simple chronic empyema. After removal of the remnants of the sac of the dermoid and rather extensive extrapleural rib resection to obliterate the cavity, the pocket closed rapidly and with the closure of the pocket, the bronchial fistulas healed.

CASE 4.—A man, aged forty-two years, came to the clinic July 6, 1932, because of pain and burning around the anus. It was difficult to obtain an accurate history of this patient's complaint because of language difficulties. The symptoms which concerned him most at the time of admission were due to pruritus ani. He also complained of a pain in the right lower part of the thorax coming on at irregular intervals noted mostly when working. The condition had been diagnosed as pleurisy. The pain had gradually become more marked with radiation to the right shoulder and was associated with dyspnea, with heavy work.

Examination was essentially negative except for prostatitis, graded 3. Distant breath sounds were noted in the base of the right lung, and some apparent dullness. The blood pressure in millimeter of mercury was 130 systolic and 80 diastolic. The pulse rate was 64. Urinalysis revealed a specific gravity of 1.028; the reaction was acid, and albumin, sugar and pus were not present. The concentration of hemoglobin was 17.5 gm. in each 100 c.c. of blood, and leucocytes numbered 7,400. The flocculation test was negative. Roentgenograms revealed a dense mass at the base of the right lung, extending from the level of the fifth rib anteriorly to the diaphragm, with rounded surfaces. The lateral view revealed an encapsulated interlobar effusion, and the fluoroscope gave evidence of a large mass at the base of the right lung. A clinical diagnosis was made of a large right intrathoracic cystic teratoid tumor rupturing into the lung and probably originating in the diaphragm.

Aspiration was performed July 13, 1932, at which time 10 c.c. of brownish fluid was removed. There seemed to be a definite obstruction to the needle when it dropped into this cavity which may have been caused by the tumor. Examination of the fluid revealed numerous cholesterin crystals and an amorphous substance, also a few scattered pus cells. A second aspiration was done July 16, with removal of 1,500 c.c. of thick, flaky material. Following the aspirations the temperature was 103.5° F. and the pulse rate 140, but the condition gradually returned to normal by August 1. Roentgenograms following aspirations revealed a large, multilocular cystic tumor with calcification of the walls of the lower loculus; the upper one was filled with fluid.

August 13, 1932, a transpleural operation was performed, with complete removal of the thoracic portion of the cystic tumor, partial excision and reconstruction of the diaphragm, and repair of multiple openings in the middle lobe of the right lung. Gas and ether anesthesia was used. The thorax was explored through a posterolateral incision with resection of the posterior half of the seventh and eighth ribs, and the cavity was entered through the periosteum of the eighth rib where a large fibrous encapsulated tumor was found extremely adherent to the lung and which had ruptured into the middle lobe of the right lung. There was no line of cleavage between this cystic tumor which had a fibrous tissue capsule and the lung. At the point where the tumor had ruptured into the lung, this encapsulated mass was opened and found to contain about 3,000 c.c. of greenish pus-like material. The thoracic portion of the mass had caused almost complete collapse of the middle and lower lobes of the right lung. The encapsulated mass extended directly through the dome of the diaphragm almost in the exact central portion, and a large mass below the diaphragm contained 1,700 c.c. of pus-like material. The thoracic portion of the sac was extremely thick and fibrous, and contained a few plaques

of calcium. The subdiaphragmatic portion was lined with calcium. The entire thoracic portion of the fibrous capsule was removed but it was impossible to do anything except to remove the calcium from the subdiaphragmatic portion, and as much of this cystic mass from the liver and diaphragm as possible and then reconstruct the diaphragm. Microscopic examination of the wall of the tumor revealed chronic inflammatory fibromyxomatous tissue, partly hemorrhagic and calcified with a few foreign body giant cells (Figs. 8 and 9).

The patient's condition following operation was critical and he was placed in the oxygen chamber and given a transfusion of 500 c.c. of blood. The thorax was

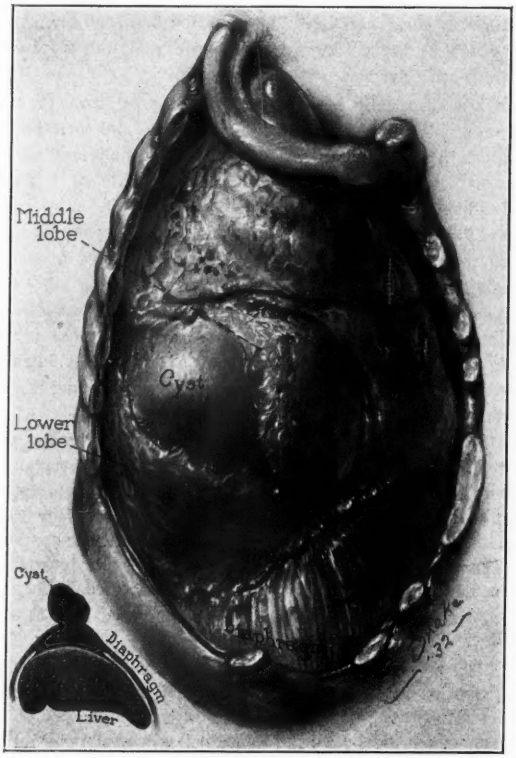

Fig. 8.—Large teratoid cystic tumor originating in the region of the right side of the diaphragm and firmly adherent to the middle and lower lobes of the right lung into which it had penetrated. Insert shows extension of the cystic tumor both above and below diaphragm.

aspirated on the day following operation, and 600 c.c. of bloody fluid was removed. August 5, 1932, 200 c.c. of fluid was removed. Seven successive aspirations on succeeding days gave negative results. The patient was removed to his room on the fourteenth day. His condition improved gradually, temperature and pulse became normal on the eighteenth day and he was dismissed from hospital on the twenty-seventh day after operation with the wound healed. Roentgenograms of the thorax disclosed the rib resection on the right side, and a pleuritic band and some bronchiectasis in the lower right side. His general condition was good (Fig. 10).

This is one of the most unusual cases of the series, particularly because of the site of the cyst which was in the right side of the diaphragm. The diaphragm had either been penetrated by the cyst or else there had been imperfect fusion of the diaphragm. It is difficult to determine definitely from what structures the tumor originated. Histologic study of the tissue did not aid greatly in solving this problem. The lining of the cyst appeared to be skin, but on histologic examination it was found to be mostly fibrous tissue with some plaques of epithelium scattered

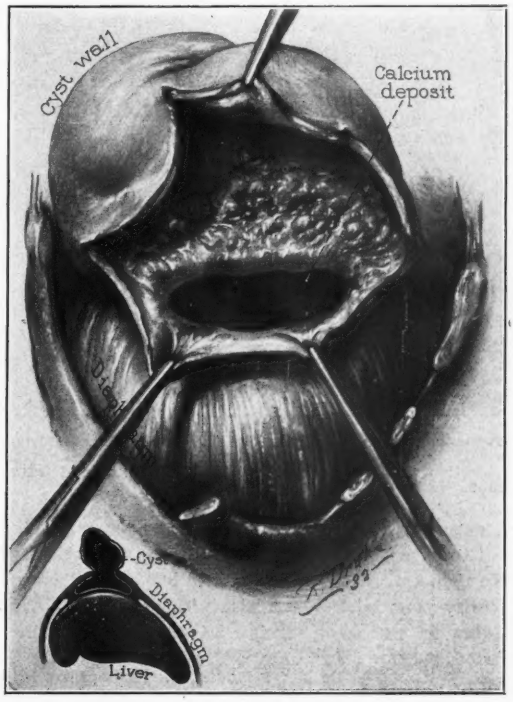

Fig. 9. Drawing made at time of operation showing the interior of the cystic tumor and large opening through the right dome of the diaphragm. About two-thirds of tumor projected into right side of the thorax and about a third below the diaphragm into the liver.

here and there. The lining membrane was almost completely destroyed because of the tremendous tension of the fluid in the cyst. The condition was unique due to the fact that there was a large opening in the diaphragm with practically as much cystic fluid under pressure between the diaphragm and the hepatic tissue as there was in the intrathoracic portion. The subdiaphragmatic portion, however, did not have the same fibrous capsule, and this cavity contained considerable calcium deposit. This subphrenic portion was entirely confined in the dome of the liver

and there was no communication with the abdominal cavity. Although it was impossible to determine definitely the type or origin of this cystic tumor, it seemed most logical to consider it of a teratoid type.

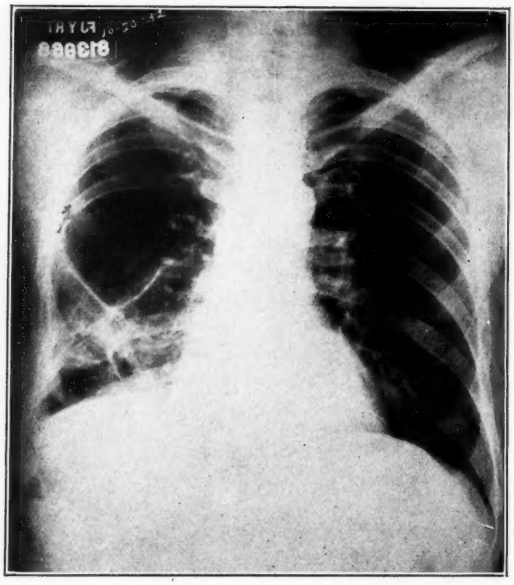

Fig. 10.—Roentgenogram made at time of dismissal after complete removal of the large right intrathoracic tumor and repair of opening in the right side of the diaphragm. Elevation of the right side of the diaphragm and intrapulmonary and pleural thickening. Lung fields were negative.

CASE 5.—A woman, aged fifty-nine years, came to the clinic May 13, 1929, because of pain of twenty-seven months' duration in the right side of the thorax, arm and back of the right ear. She had first noticed bulging of the right anterior wall of the thorax thirty years prior to admission. This remained about the same until the last year when she noticed it was increasing in size gradually. She had had periodic attacks of moderate pain in the right anterior side of the thorax for many years, usually made worse by any respiratory infection. During the last few years the distress had become gradually more severe. About two years prior to admission, she noted pain in the right arm between the elbow and shoulder. The pain was sharp and seemed to be in the muscles. For several months the pain in the arm and thorax had been more severe, especially at night. She consulted a chiropractor and was treated by manipulation, baths, and so forth. The pain had extended to both arms, and the fingers were numb. The pain became more frequent, occurring three to four times during the day and five to six times during the night, lasting from half to one hour; it was relieved only by sedatives. The patient had gradually lost appetite and strength. She had lost 14 pounds in the last year. A dry, nonproductive cough had been present for many years; it had become more severe during the last two years.

Examination revealed diffuse bulging in the right upper anterior part of the thorax. The systolic blood pressure was 195 and diastolic 110. The tumor was non-

pulsile. The pulse in both radial arteries was equal. The cervical lymph nodes were palpable in the right supraclavicular region. The concentration of hemoglobin was 70 per cent (Dare); erythrocytes numbered 4,500,000 and leucocytes 8,200 in each cubic millimeter of blood. The Wassermann reaction of the blood was negative. Roentgenograms of the thorax revealed a well defined tumor in the right upper anterior part of the thorax and calcification of the arch of the aorta. The lateral view revealed a circumscribed tumor in the upper anterior mediastinum, anterior to the arch of the aorta. Fluoroscopic examination disclosed a nonpulsile tumor.

A clinical diagnosis was made of a malignant tumor in the anterior mediastinum. The history and findings suggested mediastinal tumor of many years' duration with recent increase in size indicating malignant change. The irregular outline of the tumor, although definitely circumscribed, suggested that it might be a teratoma. The bulging over the right wall of the thorax of more than thirty years' duration, and the presence of a chronic irritating cough of many years also suggested a teratoma of long standing in the anterior mediastinum which had undergone malignant change during the last two years, and caused severe pain radiating down the arm to the back of the neck. The severity of the pain was suggestive of a malignant lesion, and removal of a gland and exploration were advised.

May 21, 1929, under local anesthesia, a gland was removed from the right supraclavicular region and proved to be a squamous-cell epithelioma, graded 4. Further surgical treatment was not advised. The patient's convalescence was uneventful.

Particular points of interest in this case are: (1) the indefinite symptoms of bulging of the anterior wall of the thorax for more than thirty years, and (2) irritative type of cough which becomes marked with any respiratory infection but never severe until the onset of pain in the last two years, with increase in the size of the tumor. This together with the roentgenographic data concerning the tumor points strongly to the presence of a teratoma undergoing malignant change. In view of the patient's poor general condition at this time, radical surgical measures were not indicated. This case demonstrates one of the most definite indications for early operation, regardless of subjective symptoms, that is, all of these tumors are potentially malignant and malignant change may occur even after a long period. It seems reasonable to suppose that malignant change in this tumor had occurred within the last two years with the onset of severe symptoms.

SUMMARY

The clinical symptoms, surgical treatment, histologic findings and operative results in eleven cases of mediastinal and intrathoracic teratoma are summarized. Five cases are reported in detail.

The most important consideration in the surgical treatment is early recognition of the tumor and its immediate surgical removal, regardless of the amount of symptoms caused by it.

Delayed operative removal may result in grave complications, such as malignant change or infection in the growth which increase the magnitude and risk of the operative procedure.

The technic of the operative removal of these growths depends on the indications in each case. The posterior method of approach when possible is preferred.

The tumor must be removed completely; a one-stage operation is preferred.

The surgical risk is not great. In this series of eleven cases there was one operative death.

The results are good in benign cases as complete cure is effected if the growth is removed entirely. The nine patients with benign lesions in the series are cured.

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DISCUSSION

DR. EVARTS A. GRAHAM (ST. LOUIS).—I would like to ask Dr. Harrington a question. I do not see why he considers that the cyst which extended below the diaphragm was a teratoma. I do not think he presented any evidence to indicate that. I do not see why it could not have been merely an infected echinococcus cyst.

DR. EDWARD B. CHURCHILL (BOSTON).—Diverging from the immediate subject, I should like to call the attention of this Society to a new type of intrathoracic tumor—the intrathoracic parathyroid adenoma.

One of the most brilliant contributions of modern scientific medicine, to my mind, is the diagnosis of hyperparathyroidism by laboratory methods. Out of ten or twelve tumors operated upon at the Massachusetts General Hospital, two tumors were located in the anterior mediastinum. They are not comparable to intrathoracic struma, because substernal goiter practically never calls for an anterior mediastinotomy by splitting the sternum.

A parathyroid tumor may not be found from the cervical approach and there is no way to determine where it may be hidden. It may be in the posterior mediastinum behind the esophagus or in the anterior mediastinum. One patient, the first case in which the disease was discovered in this country, and the second in the world, had six previous operations in his neck in a search for a parathyroid tumor diagnosed by chemical and metabolic study. At the seventh operation, in which the anterior mediastinum was exposed by splitting the sternum, a tumor about six centimeters in diameter was found lying just below the innominate vein.

The operative removal of parathyroid tumors may well be considered to come with the province of the thoracic surgeon.

DR. CARL A. HEDBLOM (CHICAGO).—In my experience nerve block and intrapharyngeal positive pressure anesthesia has proved entirely satisfactory for the control of surgical pneumothorax.

The lateral approach, it seems to me, has the advantage of lessening the likelihood of opening both pleural cavities.

With regard to differentiation between dermoids and other intrathoracic tumors the presence or absence of ectodermal structures seems to me the only sure criterion.

DR. CARL A. HEDBLOM (CHICAGO).—I just want to say that I found several intratracheal pressures, but local anesthesia has been entirely satisfactory as far as my experience has gone with this type and other types.

I think the lateral approach has the added margin of safety, and you probably will not open both pleural cavities unless the tumor is entirely mediastinal.

With regard to the differentiation of dermoids and other tumors, I have felt that no one is sure of the ground, perhaps, that a ciliated cyst is probably not a dermoid. In my series I have excluded all such cases, particularly unless they were not associated with other findings. If one does not adhere to some definition, of course, the jumble of terminology is going to be made worse rather than improved.

DR. LEO ELOESSER (SAN FRANCISCO).—Dr. Hedblom mentioned a transpleural approach, and Dr. Harrington approached the majority of these cases transpleurally. If one does an upper anterior mediastinotomy, with or without dislocation of the clavicle, one can reach some of these teratomas very well without opening the pleura.

Some of them document themselves by hemorrhages alone. I saw a Chinese girl last year who had been in a tuberculosis sanatorium for two years on account of repeated hemorrhages, whose x-rays revealed nothing except a small doubtful shadow at the hilum, not larger than a walnut, and who had a dermoid. We might have recognized it had we paid attention to the statement of her husband that she occasionally coughed out hair.

DR. HARRINGTON (closing).—I am pleased that Dr. Graham has discussed my paper and particularly that he has questioned the inclusion of the one case of a tumor originating from the right diaphragm in my group classification of teratoma. This is the only case of the entire group in which we thought there was any doubt as to its classification as I have stated in my paper. I would be pleased to receive any suggestions as to a more fitting classification for this tumor. We first classified it as originating from a ruptured amebic abscess of the liver or a hematoma of the liver which had become encapsulated by fibrous tissue but either of these sources of origin did not seem to account for the operative findings or the clinical manifestations. Doctor Broders spent considerable time in studying serial sections of this case and we decided to place it in the teratoma group because of the finding of isolated islands of epithelium of the cuboidal type in a few areas of the wall of the cyst, and we felt that the entire tumor may have originally been lined with this type of epithelium but that it may have degenerated because of the extreme pressure of the contained fluid. Several other cases reported in this series have had lining of cuboidal epithelium. The cyst was filled with a large quantity, over 3,000 c.c., of sterile fluid material containing a large quantity of cholesterol crystals. This type of fluid content was also found in other cases of this series. The cyst lining had the gross appearance of skin because of its granular character but no squamous epithelium could be found in other cases of this series and because of the small areas of cuboidal epithelium, both in that portion above and below the diaphragm, and sterile fluid containing cholesterol crystals, we felt it was most likely a teratoid type of growth, although the evidence is not conclusive. I am at a loss to know what other classification to make of it.

All of the tumors which we have considered of bronchogenic origin have contained cuboidal epithelium and have had no direct communication with a lung parenchyma. We have not included any tumor which has been lined with ciliated epithelium as this latter group we have considered as congenital cysts of the lung. These cysts

usually have a bronchial communication with the lung close to the hilus. I reported a cyst of this type which I removed last year and termed it a cystic azygos lobe of the lung.

I believe that a great deal can be accomplished in determining the etiology and proper classification of growths found in the thorax by a close cooperation between the surgeon who sees the actual location and attachments of the growth in the thorax and the pathologist who makes serial sections of the entire tumor, and I do not believe that a definite classification can be made without an accurate direct knowledge of the location of the growth in the thorax, the gross appearance of the growth, and complete microscopic study of the tissue by an experienced pathologist.

From a clinical and surgical standpoint I do not believe that the terminology or classification makes any great difference as it rarely influences our judgment as to surgical intervention. From a technical standpoint the true dermoid types are the most difficult to remove, as they are usually inflammatory and very adherent to all surrounding structures as shown in the four dermoid teratomas in this series.

BRONCHOGENIC CARCINOMA*

With Special Reference to Classification, Prognosis and Treatment

Louis H. Clerf, M.D., and B. L. Crawford, M.D.
Philadelphia, Pa.

DATA relative to tumors of the lung acquired prior to the advent of roentgenology and bronchoscopy in diagnosis were based entirely on information secured by the examination of patients with advanced lesions or from material obtained at autopsy. A great part of our present literature of pathological and statistical studies has been obtained from similar sources. While this is of great value in a general consideration of the subject, it must be admitted that, from a clinical standpoint, cancer of the bronchus should be considered in its early stages. Although there are some who believe that it is erroneous to make a diagnosis of primary cancer of the bronchus without a complete autopsy, the clinician and particularly the patient are interested in securing an opinion based on complete and thorough studies so that appropriate treatment can be promptly instituted.

We are including in this group only those cases in which the diagnosis of carcinoma was made clinically by bronchoscopy and biopsy. In all instances when the patient died in the hospital complete autopsy was performed when permission could be obtained. Much of our information regarding the classification of bronchial carcinoma and the prognosis and the results from treatment has been of a general nature.

We have found it necessary to reverse our opinions in certain cases in which the diagnosis of carcinoma was made histologically without taking into consideration the bronchoscopic findings because the subsequent progress did not conform to the usual course observed in malignancy. Bronchoscopy has afforded opportunities for repeated direct observation of growths and for securing ample material for histologic examination, thus adding greatly to our knowledge of the life cycle of many of these tumors. From the standpoint of the clinician, it is desirable to arrive at fairly definite conclusions *early* if one is dealing with carcinoma of the bronchus. The assumption that certain of these tumors have a low degree of malignancy and that others are favorably affected by certain forms of treatment indicate the need for

From the Bronchoscopic and Pathological Departments and Tumor Clinic, Jefferson Medical College Hospital.

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certain specific information that can be applied to individual cases or groups of cases. We shall therefore discuss this subject with special reference to classification, prognosis and treatment.

PREDISPOSING CAUSES OF CARCINOMA

It is not within the scope of this paper to discuss all of the predisposing factors. Certain observations, however, have been made which should be recorded. The effects of *syphilis* as predisposing to carcinoma of the bronchus is often mentioned. In a group of 50 cases diagnosed bronchoscopically and by biopsy, syphilis was found to exist in one instance. Although many of our cases had been diagnosed clinically as pulmonary tuberculosis at some time no positive laboratory evidence of tuberculosis could be found to support this diagnosis in a single case. We cannot agree with certain writers that *tuberculosis* is one of the chief etiologic factors in bronchial carcinoma. In our opinion the influence of syphilis and tuberculosis as predisposing factors is negligible and represents views which were expressed at a time when diagnostic methods were largely inferential but which still are perpetuated in medical literature. Prolonged *pulmonary suppuration* has been suggested as a possible factor in the occurrence of cancer. In our experience suppuration more often occurred in the course of cancer of the bronchus when there was interference with drainage of secretion and retention of pus due to bronchial obstruction, The occurrence of carcinoma in cases of bronchial foreign body is so rare that it may well be considered as coincidental.

INCIDENCE

Although more cases of carcinoma of the bronchus are being observed by the clinician as well as the pathologist there is a division of opinion whether this increase is actual or apparent. It can be positively stated on the basis of general hospital admissions and on autopsy statistics that the number of cases of bronchial carcinoma recorded during the past decade far exceeded those observed for any similar period. Important from our standpoint is the recognition of its frequency and its consideration as a diagnostic possibility in pulmonary disease.

TABLE I

AGE AND SEX INCIDENCE

30-39 years	9 cases
40-49 years	22 cases
50-59 years	12 cases
60-69 years	7 cases
Males, 48; Females, 2	

EARLY DIAGNOSIS

The problems involved in prognosis and treatment are so intimately related to early diagnosis that reference to this will be repeatedly

made. From the observation of Weller,[1] Funk,[2] McCrae and others,[3] and Fried,[4] one is impressed that there is no typical symptom group or clinical picture in bronchial carcinoma. The symptoms commonly observed early are those resulting from bronchial irritation, whereas the physical signs are usually those associated with bronchial obstruction. Cough, expectoration, hemoptysis and pain are early complaints but one or more may be absent. The earliest evidence of bronchial obstruction is often a wheeze. The following case report emphasized the importance of its early recognition and investigation.

CASE REPORT.—Male, aged forty-four years, developed a slight cough and wheezing noted particularly on exertion. Treatment for asthma was instituted without benefit. Because of the persistence of the symptoms another physician was consulted who recommended a bronchoscopic examination. A small sessile growth found in the left bronchus was removed for histologic examination. It proved to be carcinoma.

In the absence of secondary pathologic changes in the pleura or lung the roentgen findings are very valuable in diagnosis.[5] Pulmonary suppuration is often observed during the latter stages of carcinoma and is commonly associated with bronchial obstruction. In these, diagnosis is difficult. While a careful study from the standpoint of the history, physical examination and roentgen appearances of the chest is imperative in all cases of obscure pulmonary disease, bronchoscopy is indispensable in the early and positive diagnosis of bronchial tumors. Manges'[6] statement that bronchoscopy with biopsy has contributed more to our knowledge of pulmonary carcinoma than any other procedure is undeniable. Progress in the diagnosis of bronchial neoplasms can be made only when practitioners of medicine promptly investigate all cases of obscure chest conditions and evince a curiosity to ascertain the cause of persistent and unexplainable cough, hemoptysis, wheeze and other symptoms and signs. Final conclusions can best be arrived at by securing a careful history, making a complete physical examination and roentgen studies and a bronchoscopic examination in those cases in which it is indicated.

A large proportion of bronchial tumors have their origin in the larger bronchi and can be readily observed bronchoscopically. In a certain group springing from smaller bronchi and having a peripheral origin the bronchoscopist may find no early evidences of endobronchial growth. As the disease advances, however, the growth may intrude into a larger bronchus; or, it may, without intrusion, produce deformity and displacement of the bronchial walls. By infiltrating the bronchial wall it may produce a rigid and fixed bronchus which neither expands nor contracts nor elongates nor shortens during the respiratory cycle. The bronchoscopist, therefore, can secure positive data not only

on the basis of the actual finding of a growth and its removal for histologic examination but he also can observe the form of the bronchial lumen and the condition of its wall. Fixity and rigidity of a bronchus with or without narrowing of its lumen is strongly presumptive evidence of malignancy and, in the presence of suggestive findings by physical examination and roentgen study, a clinical diagnosis of cancer can be made.

CLASSIFICATION

In our earlier cases the bronchoscopist recorded his findings but dependence was almost entirely placed on the pathologic report of the tissue removed at bronchoscopy to determine whether it was benign or malignant. It was observed in certain of the smooth, globular, more or less pedunculated or sessile growths that there was no evidence of infiltration of the bronchial walls. These growths often were diagnosed histologically as adenocarcinoma but the subsequent clinical courses of the patients have proved that the lesion was benign. From this it would appear that the bronchoscopist should not only secure data regarding the appearances of the growth as well as a portion of it for examination but should also ascertain whether there is infiltration of the bronchial wall as evidenced by fixity, rigidity or deformity. In the nodular, fungating or ulcerated lesions, fixation and rigidity with deformity of the bronchial wall and widening of the bronchial spurs were commonly observed. The histologic diagnosis in this group was commonly squamous cell carcinoma.

The diagnosis and proper classification of bronchogenic tumors from microscopic examination of biopsies is often much more difficult and uncertain than from the study of autopsy material. Of necessity, the specimen removed bronchoscopically is often small and frequently inflammatory reaction and necrosis of the tissue render the histologic study more difficult. In a majority of cases, however, adequate tissue may be obtained by this means and a definite diagnosis may be made if the specimen is properly oriented and serial sections cut so as to have a number for microscopic study.

Two very well-defined types of carcinoma occur, namely, the squamous cell carcinoma and adenocarcinoma. These two groups comprise the greater number of bronchogenic carcinomas, but there are a number of cases which cannot be classed under either group. A number of names have been suggested for the third group of malignant epithelial tumors of the bronchus. Such terms as "medullary" and "oat cell" carcinoma are used, but it seems that such classifications serve no useful purpose as they are meaningless and are merely descriptive terms applied to the consistency of the tumor and to the shape of the predominating cell. These tumors are evidently of epithelial origin and the cells are not sufficiently differentiated for them

to be placed in any definite group, so it would seem more fitting to classify them simply as "undifferentiated" carcinomas, until we have learned more about their origin and clinical characteristics.

TABLE II

CLASSIFICATION OF BRONCHOGENIC CARCINOMA

50 cases were classified as follows:	
Squamous cell carcinoma	34 cases
Adenocarcinoma	2 cases
Undifferentiated carcinoma	14 cases

In the past we have classified some of the growths as malignant, which have proved to be clinically benign.

SQUAMOUS CELL CARCINOMA

The majority of our cases of carcinoma are the squamous cell type (68 per cent) as shown in Table II. This is a much higher percentage than is reported in statistics based on autopsy studies. We cannot explain the large predominance of the squamous cell type over the adenocarcinoma but it has occurred to us that perhaps the squamous cell type more frequently involves the larger bronchi and hence causes more clinical symptoms than the adenocarcinoma which may arise more frequently in the periphery of the lung. Whether or not this is actually the case can only be determined by further study of clinical and autopsy material. This group presents many features, both histologically and clinically, which are of importance to consider in the prognosis and treatment of these cases. The origin of the squamous cell carcinoma in the lung has created considerable discussion as the lining bronchial epithelium is the cuboidal or columnar type and stratified squamous epithelium is not normally found in the bronchial tree. It has been suggested by some that this type of tumor could arise from the lining epithelium of the air vesicles. Fried[7] and others have questioned, and apparently upon good grounds, the theory that the air vesicles are lined by squamous epithelium. In the sections from the tissue removed from the bronchus in both inflammatory and neoplastic lesions, it is often observed that, in an effort at repair, the epithelium reverts to the squamous cell type. This metaplasia of the epithelium is often observed in locations where a transitional type of epithelium is normally found, such as in the bronchial tree, esophagus, etc. The basal cell layer, of course, remains the same, and it is only a matter of differentiation, but just what specific factor influences this benign metaplasia and in malignant lesions causes the cells to differentiate in some instances into the columnar cell and in other instances into the squamous cell type, remains obscure. In many of our carcinomas a definite transition can be observed at the margin of the growth from

the normal columnar epithelium of the mucous membrane of the bronchus to the infiltrating squamous cells (Fig. 1). It would seem that, because of this frequently observed transition, there could be no question that these tumors arise from the bronchial epithelium. This view would seem to be strengthened by the fact that a number of the growths are papillary in character similar to those observed in the upper air passages.

ADENOCARCINOMA

In many tumors, the columnar type of cell predominates with the formation of indefinite acini and numerous papillae. Because of the similarity of this type of epithelium to the normal bronchial epithelium,

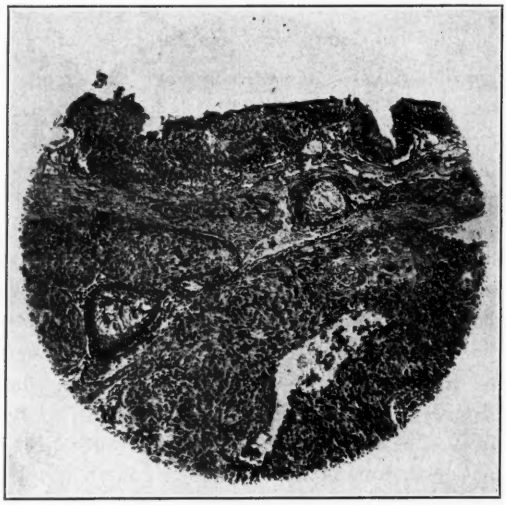

Fig. 1.—Microphotograph (×69) of a section made from biopsy material. The normal columnar epithelium of the bronchial mucosa observed on the surface at the right is undergoing transition to the infiltrating squamous epithelium. The masses of infiltrating squamous epithelium can be seen in the deeper portion of the tissue.

it would seem logical to conclude that this type of growth is definitely bronchial in origin. In one of our cases the histologic structure with small acini lined by cuboidal cells and the presence of much mucoid material was very suggestive of mucous gland carcinoma. Where the bronchial wall and surrounding lung tissue is infiltrated by the columnar epithelial cells, this represents a truly malignant growth; however, with somewhat different clinical characteristics from the squamous cell type (Fig. 2). We have encountered a number of cases where the lesion seems to be largely endobronchial and of sufficient size to obstruct a large bronchial branch; in these the histologic structure of the lesion was that of the undifferentiated adenocarcinoma, with masses of cells scattered loosely through a dense stroma. The total

absence of orderly relation between the cells and the stroma and the lack of differentiation of the cells in these growths would seem to indicate histologically a definitely malignant lesion and in the past they have been so classified. However, a number of these cases have proved by their subsequent clinical course to be benign. The growths had been removed by bronchoscopy and electrocoagulation, treatment which, in our estimation, would not be adequate to eradicate a definitely malignant lesion. We have reviewed a number of these cases histologically and have come to the conclusion that it is impossible to differentiate from the histology alone in borderline cases, between the malignant and the benign. We have therefore attempted to correlate the histo-

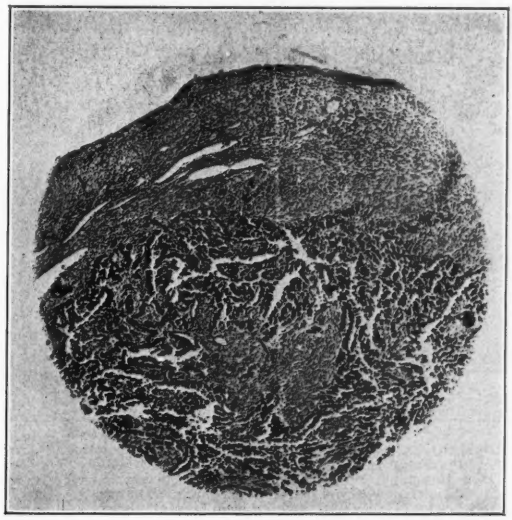

Fig. 2.—Microphotograph (×46) of a section made from tissue removed bronchoscopically in case shown under Fig. 5. The section illustrates the inflammatory reaction and fibrosis on the surface of the tumor and the masses of undifferentiated columnar epithelial cells infiltrating the deeper structures. Histologic diagnosis was "adenocarcinoma, anaplastic type."

logic and the bronchoscopic findings particularly with regard to the presence or absence of infiltration of the bronchial wall. Such findings we interpret as being indicative of malignancy.

UNDIFFERENTIATED CARCINOMA

In 14 of our cases we could not classify the lesion according to the cell type from the biopsy sections. This lack of differentiation of the tumor cells does not necessarily indicate a high degree of malignancy as there is a wide variation in the clinical courses in this group, varying between the rapidly progressive highly malignant tumor with extensive infiltration and destruction of the lung tissue and, the rela-

tively benign case. This difference in the clinical course of some of the cases could not be predicted from the histology alone. The roentgen and bronchoscopic appearances of the lesion and its location must be taken into consideration in the prognosis of the case. In one of our cases a diagnosis of carcinoma was made from biopsy sections in 1929. The lesion seemed to be fairly extensive, but it has been held in abeyance by roentgen therapy; the growth, however, is still present (Fig. 3).

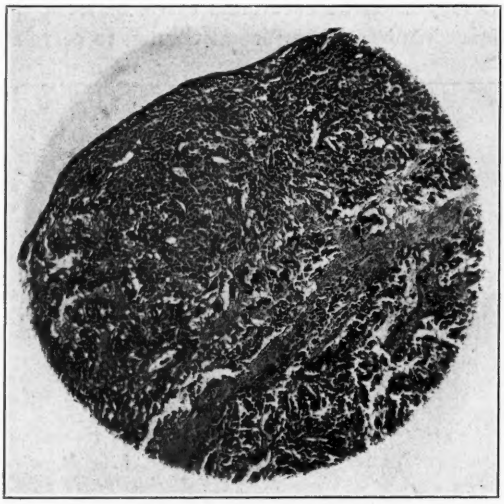

Fig. 3.—Microphotograph (×69) of a section of tissue removed from a bronchial neoplasm illustrated an undifferentiated carcinoma of relatively low degree of malignancy as the lesion has been held in abeyance by roentgen therapy and the patient is still alive practically four years after the diagnosis was made. The lesion appeared to be extensive as indicated by the bronchoscopic and roentgen examinations and is still present. A number of sections were examined from adequate biopsy material but in no location were the cells sufficiently differentiated to indicate the cell type.

GRADING

It is quite evident from the clinical course that there is a vast difference in the degree of malignancy of many of the bronchogenic carcinomas. In our group of squamous cell carcinoma there is much difference in the histologic structure of these growths as to their stage of differentiation. In some, there is marked differentiation of the epithelium with much keratinization, the growth closely resembling a true skin carcinoma (Fig. 4). In others, the cells are undifferentiated and hyperchromatic and many mitotic figures are present. We have endeavored to ascertain whether or not this difference in the cell type plays any definite part in the rapidity of the growth, the response to roentgen therapy, or the question of metastasis. So far as we have

been able to ascertain, the cell type of the tumor of the squamous cell group seems to be of very little importance in determining the rôle of the case clinically.

In the adenocarcinoma group, there is a very definite difference in the structure of certain of these growths, particularly those occurring endobronchially. We hope to be able to separate these into a distinct group. In a truly infiltrating type of adenocarcinoma, the cell type does not seem to play much part in the course of the disease. In all probability there are many other important factors, such as secondary lung infections, which are more important than the cell type of the growth.

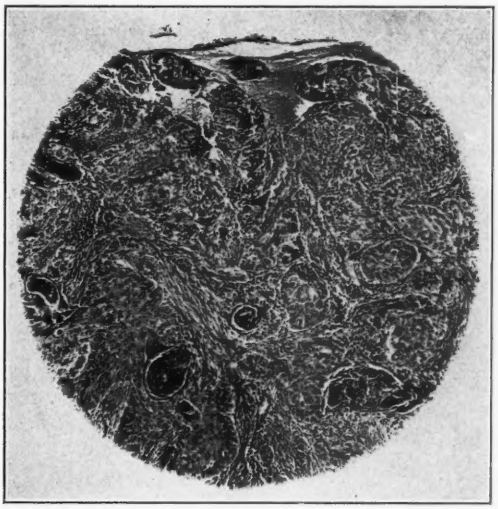

Fig. 4.—Microphotograph (×52) of section of biopsy specimen revealing extensive infiltration by masses of squamous epithelium. The infiltrating epithelium is well differentiated with the formation of much keratin in areas. The histologic diagnosis was "squamous cell carcinoma, low grade malignancy."

PROGNOSIS

A review of the literature of carcinoma of the bronchus indicated that the prognosis is not favorable although a number of cures have been recorded following bronchoscopic or other methods of removal and irradiation therapy. In our opinion, based on the analysis of a series of 50 cases of bronchogenic carcinoma that were diagnosed by bronchoscopy and biopsy during various stages of the disease the prognosis is very unfavorable.

In many of these the disease was far advanced; bronchial obstruction with varying degrees of secondary pyogenic infection was frequently observed.

The degree of malignancy of the tumor as determined by grading is not considered the most important criterion from the standpoint of prognosis. While a fatal termination may result from metastatic involvement of important organs or structures the most common causes of death are pneumonitis, pneumonia (Fig. 5), pulmonary abscess, pulmonary gangrene or bronchiectasis, usually occurring secondary to bronchial obstruction.

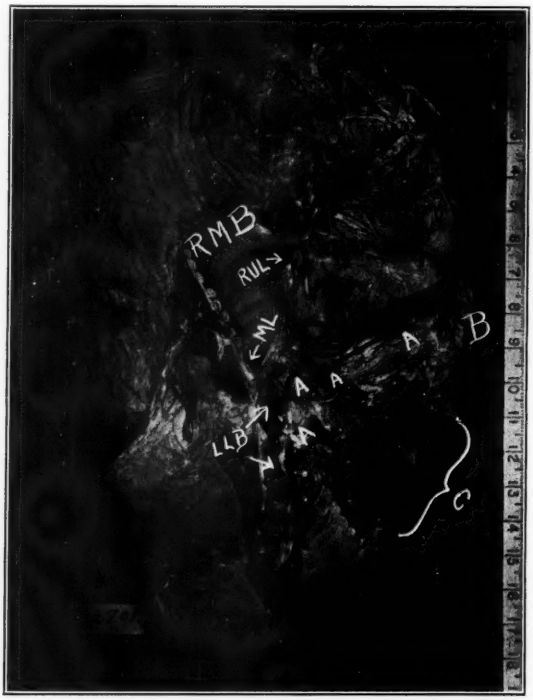

Fig. 5.—Photograph of right lung with bronchi opened exposing bronchial orifices. The specimen is viewed from its mesial aspect. For purposes of orientation the bronchi are designated as follows—R.M.B., right main bronchus; R.U.L., orifice of right upper lobe bronchus; M.L., orifice of middle lobe bronchus; L.L.B., lower lobe bronchus. A posterior subdivision of the lower lobe bronchus was completely surrounded and occluded by the infiltrating tumor (A) which also extended to the periphery of the lung (B). That portion of the lung distal to the bronchus occluded by the tumor contained numerous small cavities and areas of suppuration (C). The area of lung involved by the growth was comparatively small but there was widespread metastasis to other organs. The patient died of lobar pneumonia involving the lower lobe of the left lung. The histologic diagnosis was "adenocarcinoma, anaplastic type." (Fig. 2).

The question of metastasis is an important consideration in the prognosis of malignant diseases. Some of the factors which influence metastasis are, location of growth, organ involved, cell type of growth, and age of patient. In bronchogenic carcinoma the blood supply seems to be a factor of importance as in many of our cases of wide-

TABLE III

END-RESULTS

Squamous cell carcinoma		34 cases
Dead	31 (91%)	
Alive but failing	3	
Adenocarcinoma		2 cases
Dead	2 (100%)	
Undifferentiated Carcinoma		14 cases
Dead	12 (85.7%)	
Alive but failing	1	
Well	1	
Total mortality rate to date		90%

spread metastasis there was little or no involvement of the lymph nodes. In studying our cases and autopsy material not included in this group, we have found that metastases are much more widespread in adenocarcinoma and undifferentiated carcinoma than in the squamous cell type. In the latter, frequently metastasis was found only in the regional lymph nodes. How early metastasis occurs is impossible to say but in many cases death occurs from pulmonary infection and not from the effects of metastasis. In our group there were only two cases which developed metastases to the central nervous system in contrast to Fried's[7] group in which sixteen out of forty-seven cases had metastasis to the central nervous system.

TREATMENT

Many forms of surgical treatment varying from simple bronchoscopic removal to lobectomy and various plans of irradiation therapy have been recommended. The endobronchial use of radium has been practiced. A number of cured cases have been reported under certain of these plans of treatment. It is practically impossible to evaluate these methods for one is confronted with the question whether all of the cured cases were carcinoma or whether they were benign endobronchial growths. It is interesting to note that cases of squamous cell carcinoma do not appear in the cured group. In our experience squamous cell carcinoma is a very fatal type of tumor from a prognostic viewpoint, irrespective of the degree of malignancy as determined by grading. This does not necessarily imply that it is a rapidly growing tumor or that it metastasizes early. In these cases any form of endobronchial removal including electrocoagulation has been found useless. Many of our cases received intensive deep roentgen therapy. In certain of these the endobronchial portion of the tumor was subsequently observed bronchoscopically. It appeared that there was retardation of growth in several instances but the effects were temporary. The common occurrence of bronchial obstruction with resulting pulmonary complications has led to bronchoscopic removal of the endobronchial obstructing mass with aspiration of secretion. This

plan of treatment has given temporary symptomatic relief by decreasing cough and expectoration. In the present state of our knowledge all of these methods are not curative; their effects are temporary but as palliatives they undoubtedly have a place in treatment. In our opinion, surgical extirpation, removing one or more lobes of a lung is the only plan of treatment that offers any hope from the standpoint of effecting a cure. Obviously this is practical only if the diagnosis is made early.

In the other types of carcinoma it is believed that more can be accomplished by irradiation therapy although the end-results are not gratifying. In the benign group, at one time considered as adenocarcinoma, simple endobronchial measures designed to remove the growth and destroy its point of attachment by electrocoagulation have proved successful without recurrence of the growth for a number of years. This in itself should indicate that these tumors cannot be malignant and therefore should not be considered under bronchogenic carcinoma.

SUMMARY

A series of 50 cases of bronchogenic carcinoma are presented. A positive diagnosis was made on the basis of bronchoscopic findings and biopsy. A discussion of classification and suggestions as to changes is proposed. Emphasis is placed on the importance of distinguishing the truly malignant tumors from the benign endobronchial group which are frequently confused with adenocarcinoma.

An analysis of the end-results indicated that the prognosis was very unfavorable. Death commonly results from pulmonary complications. Treatment has been unsatisfactory. Surgical extirpation by lobectomy should offer hope provided a diagnosis can be arrived at during the early stages of the disease. In none of the reported cases was a diagnosis made sufficient early to warrant lobectomy.

CONCLUSIONS

1. Bronchogenic carcinoma has a mortality of almost 100 per cent.

2. Surgical treatment should offer a hopeful outlook if extirpation is carried out in the early stages of the disease.

3. Early diagnosis depends on prompt recognition of carcinoma as a diagnostic possibility and expediting the necessary examinations to arrive at final and positive conclusions. Bronchoscopy and biopsy may be considered as the final arbiters in diagnosis.

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EXPERIMENTAL PULMONARY ASPERGILLOSIS WITH ASPERGILLUS NIGER; SUPERIMPOSITION OF THIS FUNGUS ON PRIMARY PULMONARY TUBERCULOSIS*

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FROM the sputum of a patient with pulmonary tuberculosis with bilateral cavitation, Gaffky V, admitted to the Royal Victoria Hospital in 1928 for thoracoplasty, was grown a fungus which was identified by Mr. Charles Thom, mycologist of the Bureau of Chemistry, U. S. Department of Agriculture, as an Aspergillus niger. The spores of this fungus were very abundant in the patient's sputum and were grown repeatedly on any ordinary culture media. Care was taken before collection of the sputum that mouth contamination was eliminated as far as this is ever practicable. We felt that the spores of this fungus seen in the sputum were coming directly from the lung itself. As the man had been a farmer and a chicken raiser, it was decided to investigate the pathogenicity of this particular species, particularly as the case in no way varied either clinically or by x-ray from the ordinary far-advanced case of tuberculosis with cavitation.

The ordinary fungus commonly reported in the literature as producing either a primary or a secondary aspergillosis, is an Aspergillus fumigatus. In 1842, Bennet reported the first case in a human being and in 1856 Virchow,[1] the pathologist, was able to show the pulmonary lesions at postmortem. Rénon,[2] in his classical monograph in 1897, collected together the clinical and experimental evidence of the lesions of A. fumigatus and came to the conclusion that it was not only able to superimpose itself as a saphrophyte on a pre-existing pulmonary lesion, but was able of its own accord to initiate a serious fibrocaseous disease which might lead to the death of the host, and which was clinically indistinguishable from pulmonary tuberculosis. Renon also pointed out the difference between the experimental lesions produced by the intravenous injection of spores of A. fumigatus and A. niger. In the case of A. niger very slight lesions were produced which were in no way comparable to the large confluent caseous pseudotubercles of A. fumigatus. He discussed the causes of the variations of the two

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reactions and thought that the difference was due to more rapid phagocytosis of A. niger and not to the difference of their respective optimum temperature for growth.

Since the latter part of the nineteenth century many cases of pulmonary aspergillosis have been reported, mostly in the French and German literature, with a scattering from England, Italy, both South and North America, and Australia.[3-45] It would appear that A. fumigatus is ubiquitous and may be responsible for serious primary or secondary pulmonary disease in man, although Macaigne and Nicaud[46] are of the opinion that the experimental lesions produced in animals by the subcutaneous, intraperitoneal, intraplural, intravenous, and intertracheal routes present very different characteristics from the human clinical disease.

The finding of A. niger in the sputum, although not so common, has been reported before. Sayers,[47] in 1930, identified both A. fumigatus and A. niger from the sputum of 31 out of 125 cases of what appeared to be, by x-ray, typical healed miliary tuberculosis of the lung. Ten of the cases tested with antigens prepared from these fungi gave negative reactions with A. fumigatus, while 6 cases gave positive skin reactions with A. niger. He cautiously suggested that the miliary calcification as seen on the x-ray films might be due to the fungus infection. All the subjects, except one, were farmers, teamsters, feed mill workers, or residents of small agricultural towns where grain was marketed. Examination of the dust from hay, wheat, and various other grains showed the presence of both of these fungi. "Wheatina" is the name which has been jocularly suggested for this disease. However, no experimental work has ever been presented to demonstrate that the localized calcification in the lung may be due to fungus disease and the assumption that this may occur, although inviting, is at present unjustifiable.

Wheaton,[48] in 1890, reported tuberculosis with A. niger and Hansen[49] found 15 per cent of his asthmatic patients reacting to molds including penicillium, A. niger, A. fumigatus, A. glaucus, and A. nidulans. It is, of course, well known that A. niger is the fungus most commonly found in certain inflammatory processes of the human external ear. Since both A. niger and A. fumigatus are common and practically constant components of ordinary dust, it would seem that their mere presence is not sufficient to initiate a lesion. A basic soil of some chronic inflammatory nature would appear necessary to their growth, and for their existence as either saphrophytes or parasites. A. fumigatus is the only species of the genus aspergillus which has been experimentally proved to fulfill Koch's postulates. In the lungs of suitable animals, it produces inflammation of the bronchi, pneumonia, parachymatous necrosis and cavitation, pleurisy, bronchiectasis, atelectasis,

sclerotic fibrosis, pseudotubercles, endarteritis, thrombosis, infarcts and hemorrhages.[50-67] It was felt in our case that animal experiments might determine whether or not the presence of A. niger in the sputum was incidental or bore some causal relationship to the disease under observation.

The following scheme was carried out, employing 60 various animals:

1. Rats (18). Intranasal, tracheal, and oral injections of spores.
2. Rabbits (14). Simultaneous injections of tubercle bacillus of a virulent human strain and H. 37 with A. niger spores. Intravenous injection of spores.
3. Guinea pigs (28). Inhalation of A. niger spores by spray on regressively active or quiescent experimental pulmonary tuberculosis produced by R. 1; attempt to produce otomycosis; oral feeding of spores.

Rats.—The experiment was started with the intratracheal injection into two rats of 0.25 c.c. of a saline suspension of spores of a two-week-old culture of A. niger. One rat had a similar amount of saline to serve as a control. Two more rats had a suspension of spores forced into the nostril and two additional ones received 1 c.c. of spores by mouth. All seven rats were killed ten weeks later on March 14, 1929. Only those two receiving intratracheal injections of spores showed any lung lesions. These pulmonary lesions were so interesting in their similarity to experimentally induced pulmonary tuberculosis, that we determined to carry the experiment farther. The control rat showed only a slight hyperemia but no giant-cell formation. Seven more rats were injected intratracheally with 0.25 c.c. of saline suspension of live spores, two rats with a similar amount of dead spores, another with a similar amount of anthracite, and still another with saline only as a control. These rats were killed at varying intervals from 7 to 311 days. The following are some results:

Rat 8.—(1 week.) Received 0.25 c.c. saline suspension of live spores intratracheally. Grossly, the lung showed large pigmented areas along the mediastinal border of all lobes and scattered pinhead subpleural pigmented collections over the other surfaces. There was no pleural fluid nor adhesions. Microscopically, there was a marked peribronchial focal inflammatory reaction with the formation of a cellular exudate, mostly lymphocytes. Giant-cell formation containing 1 to 6 spores was a common feature. Many epithelioid elements were present, either swollen alveolar lining cells or monocytes. There was some conglomeration into nodule formation, with the cells staining poorly and fusing into a more or less homogeneous mass. This suggested the same process as giant-cell formation but was more extensive. Intact spores were thickly scattered in these areas. When not involved, the lung was comparatively free from any exudate, but with some dilation of

the alveolar sacs suggesting compensatory emphysema. No mycelium was seen. Wherever the spores were present a giant cell was formed. The pleura was not especially involved. At times the granulomatous inflammation extended up to the pleura; at other times it did not. The bronchi were remarkably free from exudate. The picture was essentially a localized bronchial pneumonia with the addition of giant-cell formation. There were relatively few polymorphonuclear leucocytes. The spores lay in a bed of pale amorphous cells very suggestive of early tubercle. There were in some places consolidated areas with numerous red blood cells lying in the alveolar spaces. The tracheobronchial glands were only slightly enlarged and contained an occasional small giant cell. No spores were seen. Cultures from the lung produced a heavy growth of A. niger. The culture from the trachea was negative.

Rat 9.—(21 days.) The right upper lobe was pigmented throughout. The rest of the lobe showed discrete blackish subpleural nodules with some appearance of puckering. There was no fluid nor adhesions present. Microscopically, sections showed considerable areas of the lung parenchyma relatively normal. The remaining parenchyma was completely replaced with sharply demarcated areas of granulomatous inflammation. Many areas took on a more or less peribronchial arrangement. They varied considerably in size, the outstanding feature was the sharp demarcation of these spheroidal bodies, as they completely replaced or obliterated the lung structure. The areas consisted of practically solid masses of epithelioid cells and lymphocytes. The epithelioid cells fused into large aggregations and formed pseudotumors. In the giant cells were many spores. The large masses of fused epithelioid cells were surrounded by a zone of closely packed lymphoid cells. There was no exudate in the neighboring clear alveoli. There was no fibrosis, nor was there evidence of disintegration of tissue. Some of the pale areas were suggestive of early coagulation necrosis, but not proceeding to caseation. This spherical arrangement of epithelioid cells with giant-cell formation was indistinguishable from tuberculosis except on the ground of lack of caseation and lack of coalescence. The giant cells were not necessarily in the center of these areas, but were scattered about. Macrophages were seen containing brownish yellow pigment. This was taken as an evidence of phagocytosis. Van Gieson's stain showed only a very slight amount of fibrous connective tissue in the granulomatous areas,—much less than in tuberculosis. The tracheal bronchial glands contained spores. Very heavy cultures were grown from both lungs and glands. Tracheal cultures were negative.

Rat 10.—(50 days.) Similar pigmented areas were scattered over the borders of the lung with one definitely puckered area 3 by 8 millimeters

on the right upper lobe posterior. Microscopically, the picture was very strikingly reminiscent of tuberculosis, except for a paucity of fibrous tissue and without evidence of caseation. The giant-cell formation was the striking feature. This was the last lesion which showed intact spores. In the rats killed thereafter all spores were fragmented. A heavy growth of A. niger was obtained from the lungs but none from the trachea.

Rat 11.—(128 days.) Very much the same pigmentation. There was one tough pleural adhesion present in the lower lobe on the right, running down to the diaphragm. No pleural fluid. Microscopically, the giant cells were fewer, and although the nodular areas were still present they were not so numerous nor so massive as in the other rats. Broken down spores were seen. The bronchial walls were intact. There was a conspicuous absence of polymorphonuclear cells. There was no caseation nor abscess formation. There was only very slight fibrosis. Many areas showed no fibrosis at all.

Rat 12.—(191 days.) Grossly, a large lung abscess was found in the right lower lobe containing thick, tenacious, mucoid material. Smears showed few gram-positive bacilli and cocci. There was no growth of spores of A. niger on culture. In the lung were seen the same nodular circumscribed areas about the bronchi as were seen in the other rats. The subpleural surface was studded with these nodular areas containing yellow pigment and there were only a few giant cells. No intact spores were seen. A small branch of the pulmonary artery was obliterated. There was much black anthracotic deposit below the pleura. No mycelium was seen in the wall of the abscess cavity. It was evident that the lesion of aspergillosis was present on top of a preexisting spontaneous lung abscess. This rat was an old adult one and spontaneous lung abscess in these laboratory animals is quite common. The lung abscess was similar to those previously described by Smith, Bethune, and Wilson.[68] This rat and three others were extremely valuable to us, for they provided a condition which would be difficult to produce experimentally; namely, a preexisting chronic suppurative lesion on which the fungus might be implanted. We could not demonstrate, even on such presumptively favorable soil, that this fungus would grow.

Rat 13.—(311 days.) There was mottling over most of the lung, with much puckering and scarring, no adhesions, and no pleural exudate. All cultures were negative. Microscopically, the lung showed a chronic inflammatory reaction with but very little fibrosis. Macrophages were filled with yellow pigment, both free in the alveolar spaces and also in the septal walls. No intact spores were seen. All the pigment was in the phagocytes. There was only an occasional giant cell. It would appear that the disease was regressing, having reached a maximum in

about fifty days, and then gradually subsided. No intact spores were seen after fifty days. No cultures were positive after this time. No mycelium could ever be detected in either the early or late lesions. In view of the finding of the spontaneous lung abscess in three rats and its possible confusion with the induced aspergillosis, it was decided to abandon the use of these animals.

The control rats with dead spores (spores killed by long exposure at high pressure in the autoclave and tested before use on culture media) showed a low grade inflammatory reaction somewhat similar to but not so severe as those with living spores. The alveolar walls were thickened in places. Numerous macrophages containing broken up spores were seen. There was no growth of fungus on culture. The control rats which had been given anthracite showed a rather similar low grade inflammatory reaction. There were large masses of dust in the macrophages. It was not at all difficult to distinguish between the yellow pigment of the spores and the greenish black color of the anthracite.

Rabbits.—These animals were used for the simultaneous intranasal injection of tubercle bacillus in suspension, employing two strains: one a virulent strain of our own (Caron), and the other, H. 37 with A. niger spores in suspension. Two animals were used for intravenous injection of spores. The combined lesions resulting from the intranasal use of the tubercle bacilli and the spores together varied but little from those resulting from the use of the tubercle bacillus alone. Five-tenths cubic centimeter of an emulsion of tubercle bacillus of both strains injected intranasally caused death with pneumonia, caseation, and cavity formation, not only in the lungs but also in other organs. In a few cases the combined lesions appeared to alter a more or less zonal arrangement of the tuberculous process and make the outline of the demarcated areas more diffuse and irregular. No mycelium was seen and in the animals which were allowed to die there was no growth of the fungus.

Rabbit 264.—(H. 37 only.) Killed in one month. All the pleural surfaces were studded with greyish white nodules, more on the right side and also more in the upper lobe than in the lower lobe. The nodules were more numerous in the posterior portion of the lobes. The animal had been injected, while lying on the right side, on its back. A peribronchial distribution of the nodules was seen with marked epithelioid cell proliferation and relatively few giant cells. These nodules were well demarcated and not necessarily under the pleura. The surrounding alveoli were free from exudate. There was a moderate amount of coagulation necrosis in the center of the nodules and some fibrosis was shown.

Rabbit 270.—(A. niger only.) Killed in one month. A more diffuse lesion was seen and not so sharply demarcated as in Rabbit 264. There was no coagulation necrosis, nor the conspicuous epithelioid proliferation. There was considerable exudation of eosinophiles. On the whole, this was a much more cellular and pleomorphic type of reaction. There were no multinucleated giant cells. It was much more like a typical granulomatous type of reaction; that is, cellular exudate with proliferation of fixed tissue cells. There were scattered spores in macrophages. No mycelium. Culture was positive for A. niger from the lungs only and not from the trachea.

Rabbit 267.—(A. niger plus H. 37.) Killed in one month. There were scattered raised nodules over all lobes. No gross lesions in other organs. The active epithelioid cell formation of Rabbit 264 was present, but the sharp demarcation had not been maintained. There was a small amount of coagulation necrosis, but no more than in Rabbit 264.

Considerable polymorphonuclear exudate, composed mostly of eosinophiles, was about the areas of the multinucleated cells. Some fibrosis, but not marked. Scattered spores in macrophages. No mycelium. Fungus grown from the lungs but not from the trachea.

The intravenous injection of 0.5 c.c. of saline suspension of spores produced only a slight pulmonary lesion when the animals were killed at the end of two months. They were both well and gaining weight. The reaction is in no way comparable to that produced by the intranasal injection of spores. No giant-cell formation was seen. The principal appearance was of thickened septal lining cells.

Guinea Pigs.—Following the work of Gardner,[69, 70, 71, 72] Gardner and Dworski,[73] and Gardner and Cummings,[74] on attempts to reactivate chronic and quiescent tuberculous (R. 1) lesions of the lungs in guinea pigs using various irritating dusts, we employed the inhalation method of spraying as devised by Baldwin and described by Gardner.[69] By this method, we felt that a much more analogous reaction to that produced by the inhalation of spores by man would be produced. The difference between the lesions found after intratracheal or intranasal injection and those produced by spraying the animal held in a rubber hose with only the nose projecting was marked. In the latter case the lesion was uniform and widespread, in the former more peribronchial, with large areas of the lung unaffected. R. 1 strain was selected because, as Krause has said,[75] "We have—always looked upon R. 1 infected animals as affected with self-limited healing tuberculosis and more or less comparable to those human beings who are infected but whose infection shows no tendency to progress." A three-week-old culture of R. 1 was kindly sent us by the Saranac Lake Laboratory. A suspension was made up in saline so that the content was about eight bacilli to the field. All the animals were given seven puffs with

an anatomizer of this suspension. Three weeks later they were skin tested with 0.01 O. T. and all but one were positive. Sixteen guinea pigs were sprayed with this suspension and six months later seven received a supplementary spraying with the saline suspension of A. niger spores. Two animals died before this time with nontuberculous disease. This left seven as T. B. controls. An additional eight pigs were sprayed with A. niger spores only for fungus controls. Three of these eight died in the course of the experiment, of epidemic disease. Selected animals of the three groups were killed at intervals of approxi-

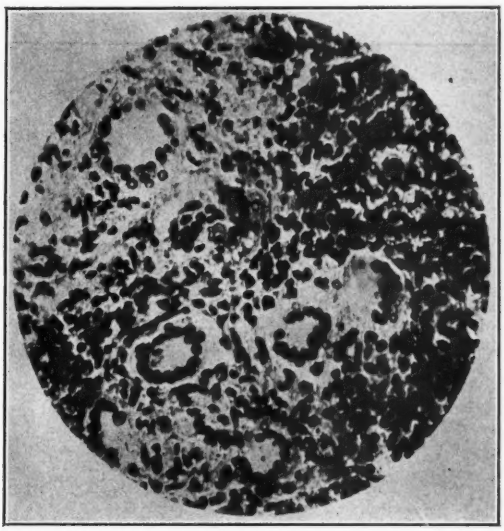

Fig. 1.—An early aspergillosis lesion, three weeks. Note giant cells with spores.

mately three months up to the end of 540 days. In addition, two pigs were used in attempting to produce otomycosis and two more were used for oral feeding of spores.

The period of six months was permitted to elapse in the first group to permit the tuberculous lesion to regress and become more or less quiescent by either resolution or fibrosis, as shown by Gardner[72] with this strain, before imposing an additional lesion of aspergillosis.

Series I.—(T. B. only.) Killed after 540 days. The majority of these pigs showed very little evidence of tuberculosis at the end of this time. There was marked lymphatic hyperplasia with here and there scattered subpleural lesions. A few small lesions were apparently healed; others were in various stages of caseation and fibrosis. Between the lymph islands many alveoli had thickened walls. The subpleural collections of mononuclear cells showed in their center casea-

tion still persisting. There was some caseation also in a few lymphoid islands. A few giant cells were observed. Fibrosis varied in different animals and was more advanced in some than in others. Apparently not all the animals inhaled the same dose of tubercle bacilli.

Series II.—(Aspergillus only.) Killed in 540 days. These animals were all fat and well. There was a chronic granulomatous lesion, widespread in distribution with much hyperplasia of the lymphoid islands, and many areas showed thickened alveolar walls and macrophages containing fragmented yellow pigment. No intact spores were seen. No mycelium. No growth on culture. There was considerable round-cell reaction about the pigment. There was no caseation, no giant-cell

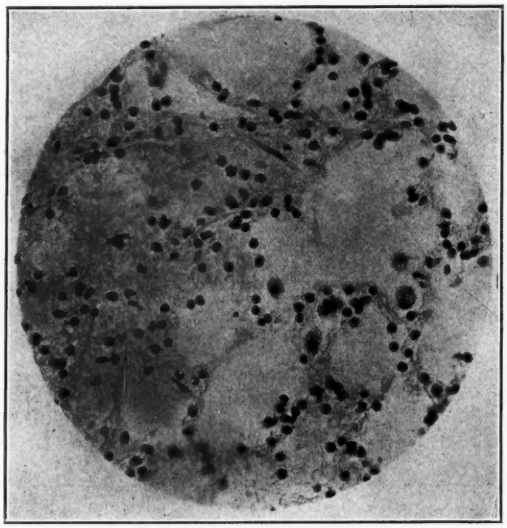

Fig. 2.—A late aspergillosis lesion, one and a half years.

formation, and little or no fibrosis. The inflammation would appear to be subsiding. The tracheal, bronchial glands were only slightly enlarged. This was a marked difference from the very large glands of Series I. Van Gieson's stain showed only slight fibrosis and in some areas none at all.

Series III.—(Combined R. 1 plus aspergillus.) Killed at the end of 540 days. These animals were well. There was a marked alveolar septal thickening with numerous scattered islands of lymphoid tissue, especially about the bronchi and the arteries. The lumina of some blood vessels were almost obliterated by the thickening of the wall. A great deal of the lung was normal. At the tip of one lobe was a typical tuberculous pleural cap with fibrosis. No giant-cell formation. Fibrosis was no more extensive than in Series I.

Spores by Mouth.—Two animals were forcibly fed with a large amount of living spores and the excreta cultured. Cultures were positive for A. niger for three days, following the feeding, but not after. Both animals were killed in two weeks with no reaction seen in the gut wall. The spleen, liver, and lungs were normal.

Attempt to produce otomycosis. The inner surface of the ear of two guinea pigs was excoriated with a scalpel and the spores were rubbed in the raw area. These areas healed completely with scab formation.

COMMENT

1. The fungus Aspergillus niger, a common component of dust and food produced, by inhalation experiments, a chronic pulmonary granulomatous lesion, regressive in nature. It appeared to produce little or no fibrosis in guinea pigs, rats, and rabbits up to a 540-day-period of observation. It did not produce caseation or abscess formation.

2. No evidence was seen of its ability to invade tissue or grow with the production of mycelium.

3. The superimposition of this fungus on a regressing tuberculous lesion was found to be nonexciting to that lesion.

4. The spores when inhaled were rapidly engulfed by alveolar phagocytes and became broken up within these cells up to a period of fifty days. By this time the phagocytes had been able to fragment them. No cultures from the lungs were obtained after this period of time.

5. No positive cultures were obtained from the trachea or bronchi after inhalation. The spores were rapidly fixed by the phagocytes.

6. Attempts to produce ulceration in the external ear failed.

7. No evidence was found to favor the theory that A. niger may be responsible for the extensive fibrosis and nodular calcification as seen in some x-ray films of human beings. To produce such fibrosis and calcification one would imagine that the original lesion, if caused by the fungus, must have been extremely widespread and of a seriously debilitating nature and produced by the inhalation of very large amounts of spores. If such were the case, this disease, in both acute and chronic forms, should be extremely common, especially among workers in grain, as this fungus is found in large amounts in grain dust.

NOTE. The fate of this patient is unknown. He left the hospital three weeks after his operation and returned to Nova Scotia. No iodine medication was advised in view of the coexisting pulmonary tuberculosis.

Our sincere thanks are due to Mr. Charles Thom for precise identification of this fungus; to Dr. T. Waugh and Dr. S. Willis for assistance in the interpretation of sections, and to Mr. Tomlinson for photomicrographs and section cutting.

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POSTURAL WEDGE COMPRESSION OF THE THORAX*

An Aid to Maximal Collapse, Prevention of Scoliosis and Visualization of a Possible Residual Cavity After Thoracoplasty

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POSTURAL wedge compression designates a procedure which applies the simple mechanical principle of leverage to the thorax for the purposes of gaining maximal compression of the thoracic wall after thoracoplasty and of preventing pleural and thoracoplasty scoliosis. The thoracic wall and spine are levered over a fulcrum with the patient lying upon his diseased or operated side over a soft compression wedge, such as a rolled pillow, as illustrated in Fig. 1. Much of the body weight is suspended upon this wedge and exerts not only great localized pressure upon the thoracic wall but also a bending force upon the spine.

Postural wedge compression has also proved to be of great value as an adjunct to roentgenographic technic when roentgenograms are taken of the thorax to determine whether or not a pulmonary cavity has been completely closed by thoracoplasty. With the spine wedged into straight alignment, that portion of the compressed pulmonary field which was obscured by the shadow of the deviated spine and which may contain an incompletely closed cavity, is clearly visualized.

For several weeks after each stage of a thoracoplasty the anterior rib stumps and soft tissues of the thoracic wall are quite plastic and permit a certain degree of molding by pressure. Consequently, postural wedge compression should be started within one or two days after operation and should be continued until the ribs regenerate, stiff scar tissue forms, and the divided and separated muscles become reattached and resume function, thereby fixing the thoracic wall in the position of maximal collapse and stabilizing the vertebral bodies in approximately straight alignment.

This procedure is well tolerated by most patients and usually can be maintained almost continuously. It has been used routinely at the University Hospital for several years and we have the impression that it has served its purpose admirably.

The spinal imbalance incident to an efficient extrapleural thoracoplasty in which the upper ribs overlying the cavernous tuberculous lesion are widely resected and removed to the very tips of the trans-

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verse processes of the vertebrae almost invariably (in 99 of our 101 cases) results in some lateral deviation of the spine. This, however, is usually slight or moderate and only occasionally severe and then only after a very extensive Schede thoracoplasty for empyema. The typical deviations usually take place in the upper dorsal region, with the convexity of the curve projecting into the operated side. Although they are rotary curvatures, they do not produce rotation thoracic wall deformities unless they become severe. They differ from all other types of scoliosis in that they involve, as a rule, only a short segment of the spine, and the curvature often is rather sharply angulated. Figuratively, the vertebral bodies appear to sag slightly into the unsupported side.

To determine the influence of postural wedging upon the spine, certain studies were carried out. The spinous processes of the thoracic spine of several patients upon whom thoracoplasties had been per-

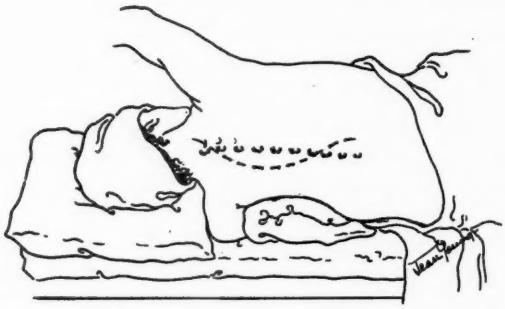
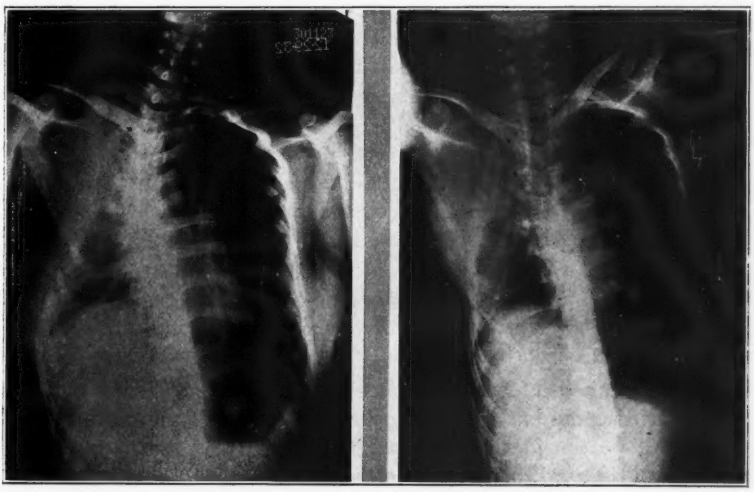


Fig. 1.—The patient lies upon the operated or diseased side over a pillow which is rolled in the direction of its long axis. It is placed so that the fulcrum of the wedge opposes or is slightly distal to the apex of the curve. Maximum correction can be obtained by removing supports from the head and by pulling strongly with the free arm upon a rung at the head of the bed. The position of the spine before and after wedging is indicated diagrammatically.

formed were marked with a skin pencil with the patients sitting upright and then with them lying upon their operated sides with and without wedge compression. If the pillow as a fulcrum was placed directly opposite or slightly distal to the apex of the curve, and the patient's head dropped until the cervical spine straightened, the marked spinous processes formed a straight line. This correction could be slightly increased by elevating the arm of the unoperated side above the head. But if the fulcrum was moved above the apex of the curve and placed high in the axilla, the curvature was exaggerated. To determine whether these changes in the spine were real or merely apparent, roentgenograms were taken of two patients in these same positions. These roentgenograms verified the visual observations. If the pillow was properly placed, there occurred the striking change in spinal contour illustrated in Fig. 2*A* and *B*.

I have the impression that the ultimate alignment of the vertebral bodies after the thoracic wall has become "set" is very much nearer a straight line in the group of patients for which postural wedge compression has been used routinely than in the group in which it has not been used.

In pleural scoliosis (the deviations produced by contracture of pleural scar from any cause, such as chronic empyema or a simple tuberculous effusion) the convexity of the curvature points in the direction of the unaffected side, the reverse of that of thoracoplasty scoliosis. Consequently, pleural scoliosis can be held corrected and possibly prevented by postural wedging of the affected side with the pillow placed high in the axilla and with the head elevated. If prop-



A Fig. 2. *B*

Fig. 2*A*.—This roentgenogram (Potter-Bucky technic) was taken with the patient sitting upright. A partial posterolateral thoracoplasty (ribs one to seven inclusive) had been done in two stages, and upon this check-up examination, seven days after the second stage, the decision relative to subsequent therapy principally depended. Note the scoliosis with its apex at the level of the sixth dorsal spinous process, and that, by overshadowing much of the collapsed lung, it conceals an incompletely closed cavity. The arrows outline the lateral border of the cavity.

Fig. 2*B*.—Same patient with postural wedge compression, patient lying upon the partially decostalized side over a rolled pillow. Note that the marked degree of correction of the scoliosis has doubled the width of the visible pulmonary field and has made it possible to visualize clearly the incompletely closed cavity.

erly applied, force is exerted upon the spine which is antagonistic to that exerted by the contracting pleural scar.

The third purpose for which postural wedge compression is used, the detection of an uncollapsed cavity as a result of visualization of a wider area of the collapsed lung, has proved to be of great value as a guide in the regulation of surgical compression by determining the need of further stages as the thoracoplasty progresses. Since

closure of the cavity is the purpose of the thoracoplasty, it is of great importance to know after each operative stage exactly what influence the progressive collapse of the thoracic wall has exerted upon the cavity. If it closes, as determined by roentgenograms, after resection of only the upper four or seven ribs in the first operative stages, further collapse may be unnecessary and the thoracoplasty terminated as a partial one. Conversely, however, should roentgenograms taken at the completion of a total posterolateral thoracoplasty show that the cavity has failed to close and the prospect of its closing with time seems unlikely, further collapse from resection of the upper anterolateral ribs or of the vertebral transverse processes and underlying costal stumps which may be preventing closure of the cavity, may be necessary.

Before the use of postural wedging, roentgenograms taken by the usual technic with the patient sitting upright (even with a Potter-Bucky diaphragm) not infrequently left doubt as to whether or not the thoracoplasty had completely closed the pulmonary cavity. If decision regarding further compression was deferred for six or more weeks and then based upon clinical data, such as the amount of sputum and the presence or absence of tubercle bacilli, performance of another stage of the thoracoplasty often would fail to close the cavity because the regenerated ribs would prevent the desired collapse. Therefore, the detection of an incompletely closed cavity before regeneration occurs may be the determining factor in the crucially important closure of that cavity.

In Fig. 2*A*, a roentgenogram taken with the patient sitting upright, the deviated spine and its transverse processes and the posterior rib stumps hide a considerable portion of the collapsed lung and in this case hide also a small incompletely closed cavity. Fig. 2*B*, a roentgenogram of the same patient, was taken during postural wedge compression. With the spinal convexity wedged toward the midline, the width of the visible upper pulmonary field is greatly increased and the cavity is definitely visualized.

This patient had had long segments of the upper seven ribs removed in two stages, the first three weeks, and the second one week before the roentgenogram (Fig. 2*A*) was taken. It was believed that the cavity was closed until the roentgenogram (Fig. 2*B*) made four days later with postural wedging technic, revealed that it was incompletely collapsed. This indicated the need of additional compression of the cavity by resection of the sheltering residual anterior stumps of the first, second, and third ribs, and the first costal cartilage, but since the patient's respiratory vital capacity had been reduced by the two previous operations to the minimal requirement of 800 c.c., the risk from a further reduction seemed to be too great to justify the

operation. Consequently, it was postponed with the hope that the cavity might close with time or the vital capacity become sufficiently increased to permit a safe margin for operation.

In a negative sense, it is of great value to have assurance that no cavity is visible in the compressed lung which has been given maximal exposure by postural wedging and in which it was known to have been present before operation. The amount of lung which is obscured by the scoliotic spine varies directly as the degree of scoliosis and lack of mediastinal fixation. When the mediastinum is not fixed to the vertebral bodies, it does not deviate with the spine but lags behind, making available a greater width of intrathoracic space to which the lung may retreat and become obscured by the spinal shadow. If the mediastinum is fixed, it moves with the spine toward the operated side.

Comparative measurements of the width of the collapsed lung at the level of the fourth thoracic vertebra were made from the roentgenograms of three patients taken with and without wedge compression. In each instance, correction of the scoliosis doubled the width of the visible pulmonary tissue; from 1½ to 3 cm., from 1¾ to 3¼ cm., and from 2 to 3¾ cm., respectively.

SUMMARY

Postural wedge compression is recommended during the early plastic period of readjustment of the thoracic wall and spine after thoracoplasty for the following purposes:

1. To mould the thoracic wall to obtain maximum pulmonary compression until the maintenance of compression is assured by costal regeneration and fibrosis.

2. To prevent or correct scoliosis until costal regeneration, scar tissue formation, and muscle reinsertion compensate for the spinal imbalance produced by thoracoplasty.

3. To aid in increasing roentgenologic visualization of the collapsed lung after thoracoplasty so that the presence or absence of an uncollapsed cavity in its mesial portion may be determined with greater accuracy to the end that collapse therapy may be more precisely regulated.

4. It is also recommended for the prevention and correction of pleural scoliosis.

Department of Reviews and Abstracts

CONDUCTED BY DUFF S. ALLEN, M.D., ASSOCIATE EDITOR

Selected Abstracts

Ken, Kure, Ryoji, Ikeda, and Fujio, Sakurasawa: Vasoconstrictor Effect of the Spinal Parasympathetic on Pulmonary Vessels. Quart. J. Exper. Physiol. **22**: 339, 1933.

These authors performed experiments on dogs to determine the effect of stimulation of the spinal parasympathetic and sympathetic nerves on the pulmonary vessels. Working on the generally accepted theory that the parasympathetic fibers are carried in the dorsal roots, animals were prepared by sectioning three or four of the ventral roots on one side and both dorsal and ventral roots on the other side and then stimulating the cord to obtain responses from the dorsal roots. To obtain responses from the ventral roots the dorsal roots were sectioned on one side and both roots were sectioned on the other, and the ventral roots were stimulated through electrical irritation of the cord. The nerves to the lungs were further isolated by crushing the exposed cord at its upper and lower ends in order to prevent the rest of the cord from being stimulated when the current was applied.

In the first series of experiments both ventral and dorsal roots of the cord were cut on one side in the upper and middle thoracic regions, and only the ventral root on the other side, and the cord was crushed at the upper and lower ends of the exposed parts. It was noted that the lung connected with the cord through the dorsal roots became pale on stimulation of the cord. This indicated that stimulation of the dorsal roots carrying parasympathetic fibers caused a vasoconstriction. This is contrary to the usual effect of stimulation of the parasympathetic fibers, i.e., vasodilation.

In the second series of experiments one lung was left attached by only the ventral roots. Stimulation of the ventral roots caused an increased redness of the lung which was interpreted as vasodilation due to stimulation of the sympathetic fibers.

In a third series of experiments simultaneous stimulation of the ventral roots on one side and dorsal roots on the other was performed. This resulted in a marked blanching on the side of dorsal root stimu-

lation and a marked redness on the side of ventral root stimulation, with striking contrast in the amount of blood in the two lungs.

In a fourth series the dorsal and ventral roots were stimulated together on one side. This caused a hyperemia of the lung, indicating that the vasoconstrictor (parasympathetic) fibers have less effect than the vasodilator (sympathetic) fibers.

Experiments were also performed with drugs applied to the lung. It was found that acetylcholine when applied to the surface of the lung caused marked anemia due to vasoconstriction. The same effect, to a lesser degree, was produced by the application of adrenalin. Histamine caused a slight anemia.

Stimulation of the vagus nerve or the stellate ganglion produced no direct influence on the pulmonary vessels.

From these experiments it was concluded that the spinal parasympathetic nerves carried in the dorsal roots have a vasoconstrictor action on the lung which is in contrast to their usual effect of vasodilation in other parts of the body. Stimulation of the fibers passing from the cord through the ventral roots (the sympathetic fibers) have a vasodilator effect on the lung. The spinal center of the nerves to the lung in both of these instances is situated in the thoracic region from the fourth to the eighth segments.

Joseph Weinberg.

Ellis, Richard W. B.: Atelectatic Bronchiectasis in Childhood. Arch. Dis. Child. **8**: 25, 1933.

The author believes that the triangular density which is occasionally present behind the heart shadow on the left or across the cardiophrenic angle on the right, in roentgenograms of the chest, represents an atelectatic lower lobe. Since the introduction of iodized oil for diagnostic purposes, the frequent association of this condition with bronchiectasis has been observed. Eight cases occurring in children are reported here. Five of the 8 have such remarkably similar histories and clinical findings that they may be considered as typical of the condition.

In every case symptoms dated from an attack of pneumonia (probably bronchopneumonia) in infancy or early childhood. At the time of examination, the children ranged from eight to thirteen years of age; symptoms had been present from four to nine years. Cough was the presenting symptom and sputum was scanty in every case. General symptoms were mild. On physical examination, the only constant finding was râles at the base on the affected side. Slight clubbing of the fingers was present in 4 and absent in 1. The triangular shadow was found on the left side in 4 cases and on both sides in 1. Lipiodol injected by the cricothyroid route in each case demonstrated tubular bronchiectasis in each triangular shadow.

The author is inclined to believe that the usual sequence of events is as follows: Bronchopneumonia in early childhood or infancy, collapse of one or both lower lobes and failure to reexpand, retention of bronchial secretions, and subsequent development of bronchial dilatations. Although the bronchiectasis was not severe in any of the 5 cases, it might become so eventually as the bronchi become more severely infected. Cough and sputum then increase and bronchi outside of the collapsed lobe become involved by spill over of sputum. It is, therefore, important to recognize the nature of the triangular shadow in the early stages and to bring about reexpansion of the affected lobe if possible. This was actually done in the sixth case where the child was observed during the pneumonia and the collapsed lobe was found early. Following breathing exercises the lobe reexpanded and lipiodol injected subsequently revealed no evidence of bronchiectasis. Every effort should also be made to prevent secondary infection and to combat it when it occurs.

He believes that the operation of lobectomy is still attended by too high a mortality to justify its use as a prophylactic measure in any of these cases. The author believes this, presumably, because enough of these cases have not yet been followed sufficiently long to know their ultimate fate.

The author presents good evidence that these shadows represent an atelectatic whole normal lower lobe and not an atelectasis of an accessory lobe as urged by Kerley (*Brit. J. Radiol.* **5**: 234, 1932. Reviewed in J. THORACIC SURG. **1**: 565, 1932). In Case 7, a triangular shadow appeared in the right base after the aspiration of a peanut and disappeared when the foreign body was coughed out. In Case 8, the shadow was thought to be secondary to tuberculosis but bronchial dilatation was present here also. These shadows have also been mistaken for mediastinal pleural effusions.

The recent increase in reports of this condition indicates that the subject is receiving more and more attention and strikes one as constituting an important contribution to the etiology and pathogenesis of bronchiectasis.

One of the cases, Case 4, had been reported previously by the author (*Proc. Roy. Soc. Med.* **25** [Part 2]: 1734, 1932).

Byron Francis.

Kjaergaard, Hans: Spontaneous Pneumothorax in the Apparently Healthy. Acta med. Scandinav. Supplementum 43, 1932, 252 pages.

This study comprises 51 unselected patients with 61 attacks of pneumothorax which the author was able to gather together in and around Copenhagen. Under this disease, for which the term "pneu-

mothorax simplex'' is suggested, are included all cases of spontaneous pneumothorax occurring in healthy persons without any demonstrable cause. No physical, roentgenologic or bacteriologic signs of tuberculosis can be demonstrated. The disease takes an afebrile course without more than the slightest degree of pleural effusion.

The greatest number of patients fell in the age group twenty to forty years, 36 were men and 15 women. A partial pneumothorax occurred in 9 cases, total pneumothorax with slight or no displacement of the mediastinum in 22 cases, total pneumothorax with moderate displacement of the mediastinum in 14 cases and tension pneumothorax in 10. In 7 patients there was more than one attack; one patient had four. From the literature, the author found a report of eleven attacks in one patient (Sale, J. C.: Lancet 85 **1**: 1572, 1907). About 20 per cent of all cases have recurrences. Subcutaneous emphysema accompanied the spontaneous pneumothorax in 2 cases.

The author was able to follow all but 2 of the 51 patients. Not one died from the spontaneous pneumothorax but 2 died of pneumonia subsequently and one patient developed tuberculosis in the opposite lung three years after recovery from the pneumothorax. Two had been well for over two years and the remainder for three years or longer at the time of the follow-up. In practice it may be taken for granted that this disease has nothing to do with active tuberculosis and therefore these patients should not be considered or treated as tuberculous or even as tuberculosis suspects.

Because of the good prognosis anatomic studies on these cases have been rare. The author found six in the literature. In these the postmortem showed that the cause of the pneumothorax had been a rupture of superficial air vesicles in the apices of lungs which were otherwise healthy. It has been demonstrated that the solitary air vesicles were formed on the basis of cicatricial changes, possibly the result of healed tuberculosis. Microscopic examination further demonstrated a one-way valve-like structure at the base of the vesicle which accounted for its distention. The author found 3 cases of valve vesicles on autopsy of patients who had died from other causes. Although in these instances pneumothorax had not been produced, these vesicles seemed perfectly capable of causing one. Two were on a base of scar tissue and one seemed to have been formed by local emphysematous changes. In the roentgenogram of one patient in the series (Case 42), who had had three attacks of right-sided pneumothorax, a large hen-egg-sized vesicle was seen protruding from the surface of the collapsed lower lobe. The author therefore concludes that the disease is due to a rupture of a valve-vesicle on the surface of the lung.

Byron Francis.

Kjaergaard, Hans: Pneumothorax Simplex. Two Cases With Autopsy Findings. Acta med. Scandinav. **80**: 93, 1933.

In his previous work on this condition, which has just been abstracted, the author came to the conclusion that all that was known of the disease—clinically as well as anatomically—suggested that it is due to a rupture of a valve vesicle on the surface of the lung. Since the patients rarely die of the disease, he was not able to make any direct anatomic examinations in any of his 51 cases. In this paper he gives the postmortem findings on 2 patients in whom the presence of dry, nonfebrile pneumothorax without demonstrable pulmonary tuberculosis was revealed as an accidental finding. Pneumonia was the cause of death in each case. In the first one, numerous small bullae varying in size from that of a hemp seed to a walnut were scattered over the surface of the left lung. One of these was found ruptured. In the second case the involvement was bilateral and the cysts were much larger, up to the size of an orange. In this case the ruptured cyst was not found. In both of these cases careful macroscopic and microscopic examination of the cysts and of the surrounding lung revealed that they were probably congenital. Again referring to the literature, the author found several reports of spontaneous pneumothorax due to rupture of congenital lung cysts. In several instances pneumothorax simplex has occurred in more than one member of the same family, which suggests a congenital disposition to valve vesicles. On the basis of these findings he now believes that the large cyst-like shadow noted on the roentgenogram in his Case 42 represents a congenital cyst. In summarizing, the author maintains that all available clinical and anatomic findings indicate that pneumothorax simplex is due to the rupture of a valve vesicle on the surface of the lung. The vesicles may be of cicatricial, emphasematous, or congenital inception.

Byron Francis.